BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:

PROPOSED SITE SPECIFIC	)	
RULE FOR CITY OF SPRINGFIELD,	)	
ILLINOIS, OFFICE OF PUBLIC	)	
UTILITIES, CITY WATER, LIGHT	)	
AND POWER AND SPRINGFIELD	)	PCB No. 2009-008
METRO SANITARY DISTRICT	)	(Rulemaking-Water)
FROM 35 ILL. ADM. CODE	)	
SECTION 302.208(g)	)	

NOTICE OF FILING

To:

John Therriault, Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph St., Suite 11-500
Chicago, IL 60601

Marie Tipsord, Hearing Officer
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph St, Suite 11-500
Chicago, Il 60601

Katherine D. Hodge
Hodge Dwyer Zeman
3150 Roland Avenue
P.O. Box 5776
Springfield, Illinois 62705-5776

Persons included on the attached
SERVICE LIST

PLEASE TAKE NOTICE that the Prairie Rivers Network today has electronically filed COMMENTS OPPOSING PROPOSED SITE-SPECIFIC BORON STANDARD FOR CWLP & SMSD in R2009-008, a copy of which is herewith served upon you.

Respectfully Submitted,

Traci L. Barkley

Traci L. Barkley
Water Resources Scientist
Prairie Rivers Network
1902 Fox Drive, Suite G
Champaign, Illinois 61820
(217) 344-2371

DATED: January 29th, 2009

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:

PROPOSED SITE SPECIFIC	)	
RULE FOR CITY OF SPRINGFIELD,	)	
ILLINOIS, OFFICE OF PUBLIC	)	
UTILITIES, CITY WATER, LIGHT	)	
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SECTION 302.208(g)	)	

PRAIRIE RIVERS NETWORK'S COMMENTS OPPOSING PROPOSED SITE-SPECIFIC BORON STANDARD FOR CWLP & SMSD IN R2009-008

The Prairie Rivers Network hereby files comments regarding R2009-008:

Prairie Rivers Network (PRN) hereby submits these comments in opposition to the City of Springfield City Water, Light and Power's (CWLP) and Springfield Metro Sanitary District's (SMSD) Petition for Site Specific Rule (the Petition) to establish an alternative water quality standard for Boron. Prairie Rivers Network is the state affiliate of National Wildlife Federation, a non-profit organization that strives to protect the rivers, streams and lakes of Illinois and to promote the lasting health and beauty of watershed communities. Much of our work focuses on how policies such as the Clean Water Act and Safe Drinking Water Act are used in Illinois - laws intended to protect our waters, our environment, and, ultimately, our health. PRN opposes the Petition for the following reasons:

A. Petitioners Have Failed to Demonstrate That Treatment of Boron to Meet the Illinois Water Quality Standard is Technically Infeasible

The burden is on the Petitioners to demonstrate that they are unable to meet the boron water quality standard due to technical infeasibility. *35 Ill. Adm Code §§ 102.202 and 102.210.* This burden has not been met. As demonstrated below, there are treatment alternatives that are technically feasible.

Alternative 1: Dry ash disposal at facilities currently discharging to Sugar Creek has not been given due consideration as an alternative to proposed site specific rule.

The existing ash ponds, both Dallman Ash Pond and the Lakeside Ash Pond, at the CWLP facility have been discharging under an adjusted standard of 11 mg/L since 1994. The boron source for those discharges is due to coal ash from wet ash handling and disposal and the flue-gas desulphurization (FGDS) blowdown waste stream. In 2003, a selective catalytic reduction (SCR) system was added, resulting in increased concentration of boron (and other pollutants) in the wastewater. The addition of this increasingly concentrated wastestream plus the pollutants already in and being added to the ash ponds have been causing violations of the NPDES boron permit limit and in-stream water quality standards. The FGDS wastestream is now proposed for transfer to Springfield Metro Sanitary District's (SMSD) Spring Creek Facility. CWLP has the option of switching to dry ash handling and disposal, which would save unspecified, yet great, amounts of power plant waste from entering the Sugar Creek and Sangamon River system. Page 92 of Hanson Engineering's technical support document (TSD) (included in petitioners' initial filing) explains that conversion to dry ash handling could eventually reduce total boron loading to the Sangamon River.

The Petition states that switching to dry ash disposal will not affect boron concentration in the FGDS stream. True, but by reducing or eliminating the amount of boron and other pollutants in the ash ponds that is eventually flushed to Sugar Creek, the overall amount of boron going into the Sangamon River is reduced. A switch to dry ash disposal and clean up of the ponds would allow the FGDS wastestream to meet the adjusted standard already granted for Sugar Creek. Moreover, switching the CWLP facilities to dry ash handling and disposal could ultimately reduce loading to the Sangamon of several additional pollutants.

Besides the obvious problem with high boron concentrations and loading, power plant waste in the form of fly ash, bottom ash and scrubber sludge contains concentrated levels of contaminants like arsenic, mercury, chromium and cadmium that can damage the nervous systems and other organs, especially in children. Further, these wastes have degraded our public ground and surface waters impacting many uses including consumptive, agricultural, industrial and environmental. Studies have also documented multiple developmental, physiological and behavioral abnormalities in many species of amphibians and reptiles inhabiting wetlands near coal ash disposal sites.

It appears that CWLP may have intentionally foreclosed the option of dry bottom ash handling. Hanson's Technical Support Document (TSD) refers to Burns' (New Generation Project Water Study, (2005), (Attachment B to Petitioners Post-Hearing Document Submittal) conclusion that dry fly ash handling is costly, and dry bottom ash handling is "not favored" due to lack of space. However on p.40, Burns notes that space requirements could be an adverse factor in planning for the new unit. Note, however, that the Lakeside unit is being demolished, and that the water treatment plant is being massively renovated, especially the pumphouse, possibly opening new opportunities for locating equipment for dry bottom ash. Burns also notes that earlier studies (Sargent & Lundy 2003, and Hanson 2004**)** disregarded the possibility of pumping ash pond discharge back to the lake or to the power plant, because it contained the extremely high-boron FGDS stream. Burns recommended treating the FGDS wastestream separately (brine concentrator/spray dryer) thus making pond discharge clean enough to recycle or re-use.

Burns proposed two other options (4 and 5) that would, respectively, recycle or re-use sluice water. Option 4 would recycle the bottom-ash sluice water, as originally suggested by the S&L report as a feasible alternative to dry bottom ash handling. Recycling would increase the concentration of the small fraction discharged as blowdown. Instead of discharging the blowdown into ponds, it could be used in the FGDS. Option 5 would pump the sluice water back to the plant for pretreatment, and then use it (instead of raw lake water) to evaporate in the new Unit 4 cooling tower. These options are viable and must be considered by CWLP.

Option 5 might occasionally need to discharge to ponds during rare Unit 4 outages, unless the pretreated sluice water could be used elsewhere on the site or stored temporarily. These possibilities led Burns to refer back to earlier Hanson and S&L studies that discussed groundwater contamination at the unlined ash ponds. For purposes of broadening the scope of the interrelatedness of these choices with protection for more than just the 100 miles of river at issue, we include the following from Sargent and Lundy, p 6-5 (2003) (Attachment C to Petitioners' Post-Hearing Document Submittal).

> The previous water conservation study by Hanson included theoretical modeling and laboratory simulation of closed loop ash handling system operation. In addition to boron, Hanson concluded that concentrations of several other water quality parameters and various metals could either exceed the Class I groundwater standards or the additional groundwater limits established as part of the scrubber sludge landfill operating permit. Although a detailed review of the Hanson results is beyond the scope of this study, we agree with their basic conclusions regarding this issue.

Burns notes on page 32 that boron leaching from ash ponds could still be a problem unless all fly ash sluicing is terminated. Continuing on p. 36, Burns notes that Hanson and S&L studies refer to possible need for "repermitting or lining" the ash ponds to comply with groundwater standards if, for any reason, concentration in sluice water should increase. This could occur as, for example, a result of greater water recycling and concentration of the ash pond water.

As expressed at the December 16th hearing, PRN is concerned that there might be a loss of boron and other dissolved pollutants through the groundwater which would create a lower effluent concentration from the ash ponds. If this is the case, then the values used in modeling and evaluating boron mitigation and treatment options might be skewed and ultimately underestimated. Additionally, this would allow an artificial estimate of loading of boron and other pollutants to Sugar Creek and the Sangamon River.

In addition to keeping many pollutants out of the Sangamon River system, the dry ash alternative would save more than 4 MGD of raw water now being used to sluice ashes from existing plants. We have learned from the Final Environmental Impact Statement (Section 2.2.6.1) for the proposed dam and reservoir also known as Hunter Lake, that nearly 3.3 MGD is lost from CWLP's unlined ash ponds due to evaporation and seepage into the ground. The water seeping into the ground is likely draining towards groundwater and Sugar Creek, thereby contributing to increased boron concentrations and loadings to water resources.

Finally, as noted in the transcript for the December 16th hearing (p. 16-18), several other coal-fired electric generating stations in Illinois sell their coal combustion waste to be used as beneficial by-products. Currently, CWLP sells 85% of their ash from Unit 33 for fill material on construction projects and 85% of the ash from Units 31 and 32 for use by asphalt and roof shingle companies. The remaining 30% of the total ashes sluiced to the ash ponds are not currently considered usable. When asked why the remaining material was not considered usable, Mr. William Murray explained that local markets did not exist. PRN would like to see the Board encourage or promote CWLP to identify markets that could use the remaining 30% of generated ash waste. Not only would this cost nothing for CWLP, it would actually generate funding for other projects at the facility, possibly appropriate boron treatment technology.

<u>Alternative 2. The use of brine concentrator/spray dryer equipment for a zero liquid discharge from the CWLP facilities has not been adequately considered.</u>

CWLP abandoned equipment purchased that would have concentrated and dried the brine solution, ultimately sending the pollutants to a landfill. Reasons cited include high cost, difficult disposal of solid waste generated and new application of technology. These reasons are unsubstantiated by the Petitioner and there is evidence that the technology remains a feasible alternative. In a letter dated December 29, 2006 from William A. Murray, Regulatory Affairs Manager for the City of Springfield to Albert Ettinger, Senior Staff Attorney for Environmental Law and Policy Center, Mr. Murray states “Burns and McDonnell’s study provided a recommendation to CWLP to pursue a brine concentrator/spray dryer system for the treatment of wastewater from the new and existing plant facilities. Though this system has a slightly higher capital cost over the other technologies, the *proven* (emphasis added) application coupled with the more simple operation would provide a more effective and reliable system for treating wastewater from the plant facilities.”

In 2005, CWLP purchased the brine concentrator, spray dryer and related components from Aquatech for $7M. This equipment would remove the salts (including boron) from the wastestream by first concentrating it (brine concentrator stage) and then evaporating the water out of it (in spray dryer). At one point, Aquatech recommended using a softener/crystallizer, as used in several plants located in Italy, which would replace the spray dryer and work to precipitate the salts and squeeze the water out. This process produces a solid waste that is relatively easy to handle and very pure water that is then recycled to the power plant. It is not clear why CWLP chose the energy-intensive spray dryer option for their second stage when the same vendor was designing plants elsewhere in the world to use the softener/crystallizer option. It is our understanding that the crystallizer option is cheaper at the second stage, but it does requires pre-treatment (softening) of the FGDS waste stream before it enters the first stage (brine concentrator). CWLP already conducts conventional treatment (lime and soda ash softening), converting the calcium salts in the purge water to sodium, thus paving the way for treatment in the brine concentrator/crystallizer system.

Petitioners claim that use of the Aquatech equipment is a new application of the technology and is yet unproven. On the contrary, the equipment is being used successfully at five power plants in Italy and is scheduled for one additional facility in Italy and for Kansas City Power & Light (KCPL) in 2009. Although the Petition states that brine concentrators have not been used to treat an FGDS stream, these facilities have the same SCR/FGDS technology as CWLP. In fact, a paper demonstrating the technical feasibility of the Aquatech alternative for treating FGDS wastewater from coal-fired power plants was presented at the International Water Conference in San Antonio in October of 2008. The submitted abstract states the following:

> **Zero Liquid Discharge Systems Installed for ENEL Plants in Italy**
> M. N. Rao, Aquatech International Corporation (*Canonsburg, PA, USA*);
> Sergio Donadono, ENEL (*Milano, Italy*)
> Aquatech International Corporation was awarded the contract to supply and install ZLD systems to treat FGD waste water from five coal-fired power projects for ENEL (Ente Nazionale Energie Electtrica) in Italy. Each plant receives a wide

variety of coal that throws challenges in the treatment of this wastewater. Some of the challenges include high concentrations of suspended solids, dissolved ionic impurities e.g. calcium, magnesium, sulfate, heavy metals and chloride ions as well as large fluctuations in the FGD wastewater blowdown quantity and quality. Company has supplied the systems with softening the FGD waste stream as a pretreatment step before it is routed into the ZLD systems. This paper discusses design considerations and concept applied and compares the initial operational data from the plants commissioned.

At the time of this letter, the formal published paper was not available for distribution.

A webinar by Devesh Mitall of Aquatech International entitled "FGD Purge ZLD" (attached as Exhibit 1) also demonstrates the technical feasibility of this alternative.

Items to note include the following:

Slide 4: Four coal fired power plants in Italy have converted to a "zero liquid discharge" system. One more is under construction. Each facility has employed a brine concentrator and crystallizer designed by Aquatech.

Slide 5: The range of concentrations of boron for these facilities includes the approximate boron concentrations of 450ppm produced by CWLP facilities.

Slide 17: Pictures provided show that the byproduct can be handled, bagged and disposed of, in contrast to the opinion expressed by CWLP's Doug Brown at both the November 3 and December 16 hearings (transcripts, p. 51 and p. 36, respectively)

Slide 23: Burns and McDonnell have served as consultants to Kansas City Power & Light (KCPL) and have recommended the brine concentrator system that will be installed at the new facility going on line in 2009.

Several other documents describing Aquatech's technology are attached as Exhibits 2, 3, 4, 5, and 6. Other companies are also designing plants to use this technology in Italy and elsewhere, for example HPD, a Veolia Water Solutions & Technologies company based in Plainfield, Illinois: Shaw, William A. 2008. "Benefits of Evaporating FGD Purge Water." Power. (March). 59-63. Available online at: http://www.powermag.com/powerweb/archive_article.asp?a=60-F_WM&y=2008&m=march.

We encourage Petitioners and members of the Illinois Pollution Control Board to contact the authors of these papers (W. A. Shaw, M.N. Rao or D. Mitall) with additional questions regarding the application of this technology at the CWLP Dallman facility.

B. Petitioners Have Failed to Show that Treatment of Boron to Meet the Illinois Water Quality Standard is Economically Unreasonable.

Petitioner must provide economic justification for the proposed rule as well as a demonstration that the general rule is economically unreasonable. *35 Ill Adm Code §§ 102.202 and 102.210.* As shown below, Petitioner has failed to meet these burdens and the Petition must be denied.

1) <u>The long term operating expense of the proposed transfer and acceptance of the FGDS wastestream to the SMSD Spring Creek Plant is the second most expensive option and has virtually no realized environmental protection.</u>

SMSD has contracted with CWLP to accept the FGDS wastewater stream, at a cost to CWLP of $100,000/month, provided that its acceptance does not upset normal plant operations. (Petition, p. 36) The estimated capital cost of the pretreatment system including the pipeline to transfer the pretreated FGDS wastewater and chemical feed system(s) to control odor to the SMSD Spring Creek Plant is $15.5 million. The annual operating and maintenance cost, including the monthly payment to SMSD is $1.6 million. Assuming that the monthly payment to SMSD will remain fixed and other annual operating and maintenance costs will escalate by $10,000 per year, a pretreatment system life of 30 years, and an interest rate of 8 percent, this equates to a present value of $36,100,000 (a present value per electric service of $544). (TSD, p.18) Comparing these values with those presented in Table 6-2 from the TSD entitled “Cost of Treatment Alternatives for the Removal of Boron” we see that the alternative proposed by this petition is the second most expensive option and does not actually treat or remove any pollutants other than suspended solids.

2) CWLP has squandered $7M in equipment purchases (now abandoned) and consulting fees to arrive at their ultimate solution of dilution.

In December of 2005, CWLP entered into a contract with Aquatech International Corporation to provide equipment and technology for the wastewater treatment process at CWLP's power plant. CWLP requested a brine concentrator and spray dryer system and was informed by Aquatech that high energy consumption of the spray dryer would impact operating expenses. Aquatech proposed the installation of a crystallizer after the brine concentrator instead of a spray dryer to address calcium chloride issues and produce a solid waste stream that is easier to handle. According to Aquatech, the crystallizer could significantly lower operating costs and allow CWLP to recoup the cost of the crystallizer within a few years. Despite this recommendation, CWLP did not purchase the crystallizer and instead moved forward with bidding for the brine concentrator and spray dryer. Further, the equipment package (supply only) presented to CWLP by Aquatech was only approximately 15% of the capital cost of $50 million that CWLP has cited in support of this petition.

3) Failure to implement water conservations measures at CWLP's power generation facilities results in increased loadings of boron and unnecessarily increases the cost of boron treatment.

Water conservation at CWLP's power generating facilities would allow CWLP to meet the water quality standard for boron. By conserving water as suggested by the consultants Sargent & Lundy and Burns & McDonnell, Petitioner CWLP could substantially reduce its boron loadings to the Sangamon River system and eliminate the need for an adjusted standard. Burns' analysis of the water conservation benefits of alternative ash handling technologies was biased by their assumption (apparently at CWLP's direction) that conserved water was worth only $1.39/million gallons, which appears to be the cost of pumping it out of Lake Springfield (Burns, p. 7-2). Elsewhere in their report Burns noted that the benefit of water conservation would be greater if additional supplies had to be procured. In fact CWLP has for 20 years been seeking a Clean Water Act permit to spend more than $108M on a supplemental water supply.

C. Petitioners Have Failed to Provide an Accurate Assessment of the Environmental Impacts of the Proposed Site-Specific Standard for Boron.

Petitioner must provide sufficient environmental justification for the proposed site-specific rule in accordance with *35 Ill. Adm. Code § 102.202*, including a detailed assessment of the environmental impacts of the proposed change. As shown below, the environmental impacts will be far greater than revealed by Petitioner, making the proposed rule unjustifiable.

1) <u>FGDS wastestream will contain more than just boron.</u>

First, it is important to note that all four stream segments of the Sangamon River at issue in this Petition are considered impaired by the Illinois EPA and as such are unable to support their designated uses. Of particular concern is stream segment E-26, impaired for the designated use of aquatic life due to excessive levels of boron, total suspended solids, total dissolved solids, silver, total phosphorus, total nitrogen, fecal coliform and polychlorinated biphenyls (PCBs). Segment E-26 is the Sangamon River from the South Fork of the Sangamon River to Spring Creek. This is the segment immediately downstream of where Sugar Creek, also impaired, empties into the South Fork of the Sangamon River.

Second, the discharge will contain a plethora of pollutants in addition to the boron loadings. According to the Petition, “The FGDS blowdown is a means to remove chlorides and other contaminants that would otherwise buildup in the system and cause a corrosive environment in the stainless steel towers.” (p. 15). We know from other similar facilities and from the Petitioner’s technical support documents that the FGDS wastestream will contain boron, sulfates, TDS, TSS, nitrate, ammonia, selenium, iron, cadmium, mercury, and manganese. Despite the presence of these additional pollutants, Petitioners have stated that the wastestream from CWLP will not receive any additional treatment at the Springfield Metro Sanitary District Spring Creek Facility, other than dilution. *See* December 16, 2008 Transcript of Hearing IPCB, pp. 41-43.

2) Organisms sensitive to boron are present in the receiving stream and must be protected.

Aquatic plants play an important role in providing habitat, forage and breeding protection for several types of aquatic residents in river systems. Although the Petitioners have conducted a macrophyte survey at three locations within the 100 mile section of the river(s) for which the adjusted boron standard is proposed, it appears that the survey does not provide sufficient study of the affected stream and river beds or of the existing macrophyte stands. The macrophyte study was conducted at Illinois EPA's established monitoring sites E-24, E-25 and E-26 located at Petersburg, Oakford and Riverton respectively. A review of the material submitted in support of this Petition does not make clear how much square footage of the stream and river beds were examined. It is important to note that even if 5280 linear feet (1 mile in length) were surveyed on both sides of the river, which is extremely doubtful, only 3% of the entire study length would have been surveyed (3 miles out of 100 miles). Further, without a more thorough examination of what other habitat, forage materials and breeding sites are available for aquatic life to utilize, it is impossible to determine how critical a role existing macrophyte stands play in the growth, reproduction and survival of the macroinvertebrates, mussels, reptiles, amphibians, mammals and fish currently residing there.

In addition, there is no evidence that Petitioners conducted a wetland survey in the 100 mile length of river proposed for increased boron concentrations. Considering that many plants are sensitive to low levels of boron, it is essential that Petitioners complete such a survey to accurately determine the impact of boron on wetlands and to avoid their illegal destruction.

In 1994, an adjusted standard of 11mg/l was granted for CWLP and SMSD process discharges to Sugar Creek for effluents high in boron, among other pollutants. This adjusted standard has been in existence for nearly 15 years and provides an opportunity to study the biota quality and quantity prior to and since the adjusted standard was granted. When asked if the Petitioners or the Illinois EPA had conducted such a study to help inform assumptions and predictions likely to result from the higher concentrations of boron, etc in the Spring Creek and Sangamon River system from an adjusted standard, the reply was no.

Further, Mr. Mosher of IEPA asserted that, because of the permit violations and levels of boron exceeding 11mg/L to Sugar Creek, that any results of such a study would not be comparable to anticipated conditions if an adjusted standard of 11mg/L were granted for Spring Creek. After reviewing the concentrations of boron for segment EOA-01 on Sugar Creek (IEPA's Post-Hearing Document Submittal), downstream of Outfalls 003 and 004, Mr. Mosher's opinion is unfounded. Of 72 values provided for the period spanning January 1999 to February 2007, only six values exceeded 11.0mg/L and were as follows: 14.0mg/L, 12.0mg/L, 15.0mg/L, 13.0mg/L, 16.0mg/L, 17.0mg/L. The average concentration of boron during this period was 4.71 mg/L.

The Petition (p. 27) claims that "The *Technical Support Document for Petition for Adjusted Boron Standards for Sugar Creek and the Sangamon River* (Hanson Engineers Incorporated, March 1994) presented scientific evidence showing no detectable degradation to Sugar Creek receiving discharges having boron levels as high as 18 mg/L of boron. The 1994 Hanson study demonstrates the toxicological effects of boron at varying concentrations on the biological community of an aquatic ecosystem." This report does not <u>demonstrate</u> anything, however, it only predicts. Now, Petitioners and the Agency have the opportunity to examine whether their predictions played out as expected in order to inform the Petition at hand and its anticipated outcome. To not do so is unscientific and irresponsible.

3) Boron water quality standard should be upheld and applied as enacted, until a literature review and additional toxicity work is completed and determines that existing uses can be protected with a revised standard.

IEPA personnel have asserted that the water quality standard is overprotective for aquatic life and that the Illinois WQS was set at the level of 1 mg/L to protect irrigated crops sensitive to boron. There are a number of problems with this argument. First, the rationale behind establishing the water quality standard for boron has not changed. Boron is an essential nutrient required especially at the early stages of the plant's growth. At slightly higher concentrations, more than about 0.3 mg/L in the irrigation water, boron can be toxic to boron-sensitive plants. Boron is adsorbed by the oxide surfaces of particles of soil and is not readily leached, and may accumulate to toxic levels in the root zone. Agricultural crops such as stonefruit trees, grapes, garden vegetables, berries, wheat, beans and corn (p. 219, Table 3 in Boron and Its Role in Crop Production by Umesh C. Gupta, available online at http://books.google.com/books?id=TmusnFj-0zoC&printsec=frontcover&source=gbs_summary_r&cad=0), are still sensitive to boron, still grown in Illinois and still have the potential to be irrigated with Sangamon River water. In fact, in consideration of future modeled scenarios in which irrigation may become critically important as a result of climate change, we ought not to foreclose the option of irrigating from 100 miles of river in some of the state's most important farmland.

Second, the Illinois EPA has announced that they will be contracting with the Illinois Natural History Survey to further develop the boron toxicity database with the intention of revising the boron standard. We do not agree with the Agency that the existing toxicity database summarized by CWLP is adequate for the site-specific demonstration, and maintain that the requisite information for deriving a revised water quality standard must apply in all instances of a standard change, site-specific or not. Prairie Rivers Network asserts that until the Illinois EPA has completed their literature review and the INHS has completed their additional toxicity work, the boron water quality standard should be upheld and applied as intended.

It should be noted that the federal criteria for boron is 750ppb. The Ministry of Water, Land and Air Protection for the Canadian Council of Ministers of the Environment (CCME) have set the ambient water quality guideline to protect freshwater life at 1.2 mg/L and to protect the water use of irrigation between 0.5 mg/L and 6.0 mg/L (http://www.env.gov.bc.ca/wat/wq/BCguidelines/boron/boron.html). The State of California publishes a notification limit of 1 mg/L for boron. The USEPA is considering boron as a candidate of future regulation (EPA, 2005) and currently recommends average lifetime exposure to boron be kept below a concentration of 0.6 mg/L (EPA, 1992).

D. The Illinois Pollution Control Board Cannot Grant a Site-Specific Water Quality Standard That is Inconsistent With Federal Law

The Petition must demonstrate that the Board may grant the requested relief consistent with federal law. *35 Ill Adm. Code § 102.210 (e).* Revisions to or adoptions of new water quality standards must be submitted to the Administrator of the United States Environmental Protection Agency (EPA) for review and approval in accordance with the Clean Water Act. *33 U.S.C. § 1313(c), 40 C.F.R. § 131.20(c) (2)* A water quality standard is a legally binding norm that describes the desired ambient condition for a waterbody and includes “the magnitude (e.g. concentration), duration, or frequency that the State would use to determine whether a waterbody is attaining any applicable water quality criteria. *EPA Region 10. “Water Quality Standards: Authorities, Definitions & Considerations.”* (January 13, 2009).

Clearly, a site-specific standard for boron is a water quality standard. As such, it must be submitted to EPA for review and approval in accordance with the federal Clean Water Act and its implementing regulations. A new or revised water quality standard has no effect until EPA approves the change. *40 CFR § 131.21(c)*. Should the Board grant this Petition, the change in water quality standards must then be submitted to EPA for its review and approval.

In addition, while the Board is not charged in this proceeding with determining whether the necessary NPDES permits will be granted, the whole point of obtaining an adjusted standard is to allow Petitioners to obtain the permits and to discharge additional pollutants in accordance with those permits. Because Petitioners will be seeking to discharge additional pollutant loadings into the Sangamon, the additional loadings of boron and other pollutants must comply with the state's antidegradation regulations. *See* 35 Ill Adm. Code § 302.105 (requiring a demonstration that existing uses will be fully protected.) *35 Ill Adm.Code § 302.105 (c) (2) (B).* As noted above, however, Petitioners have inadequately demonstrated that the increased loadings of boron will protect the existing uses in the Sangamon River. At this point, Petitioners have not even fully accounted for the existing uses in the receiving streams. Both federal law and the Illinois Administrative Code call for a detailed assessment of existing uses and the environmental impact of the requested relief on those uses. The requested relief cannot be granted until Petitioners can show the full extent of those impacts and provide a scientifically supported assurance that those uses will be protected despite the increase in boron loadings.

Federal law also prohibits a new discharge of pollutants to impaired water bodies where the discharge would cause or contribute to a violation of water quality standards. *40 C.F.R. § 122.4 (i)*. In this case, CWLP is seeking to send a new wastestream to SMSD's sewage treatment plant. As noted above, that wastestream would contain pollutants such as TSS, TDS and ammonia that will ultimately be discharged to the Sangamon River, a river that is already impaired by TSS, TDS, total phosphorus and total nitrogen. Adding additional loadings of TSS, TDS and a deoxygenating waste such as ammonia will place additional strains on an already impaired water body that could cause a violation of water quality standards. By granting the site-specific standard requested without further evidence of the impact on water quality, the Board would be setting the stage for a possible violation of federal law. The requested relief should not be granted without further study and assurances that the diverted waste stream will not cause or contribute to the impairments in the Sangamon.

Additionally, it is not clear how SMSD will be able to meet other parameters in their NPDES permit with the addition of the FGDS wastestream. In March 2004, SMSD informed CWLP that it would not accept the wastestream from CWLP due to high concentrations of chloride. Nevertheless, the Petition (page 14) states that "pumping the CWLP FGDS wastewater to the SMSD Spring Creek Plant is not expected to have any effect on the Plant, other than the increase in boron concentration in the effluent." Given this discrepancy, we urge the IPCB to further investigate how the SMSD will be able to meet their NPDES permit limit for chlorides of 500 mg/L (35 Ill Adm. Code *§* 302.208) with the additional wastestream.

Moreover, although SMSD now claims that CWLP's 270,000 GPD wastestream will be insignificant compared to the 20 MGD flowing through the Spring Creek plant, it will be difficult to meet the proposed adjusted standard of 11 mg/L during times of drought when enough water may not be available for dilution. CWLP's proposed solution is to use holding tanks. The Petition states CWLP proposes collecting the FGDS wastestream in a 250,000 gallon influent holding tank. This tank will provide about 22 hours of holding time for the wastestream, anticipated to be approximately 187 gpm. Though Petitioners assert that it is not their burden to characterize drought conditions for the last 25 years (December 16 hearing transcript, p. 33), we disagree. The most recent significant drought for the Springfield area occurred in 1988-89, 20 years ago. Any plans to meet NPDES permit conditions and water quality standards should take into account possible and likely conditions. It is precisely during these drought conditions, when the proposed adjusted standard for boron of 11 mg/L is unlikely to be met, that river water will be used for irrigating adjacent agricultural fields.

Petitioners further state that the system can be cycled through or cycled up as the water is reused in the process to allow for an additional two days' worth of storage time. When wastewater is recycled and reused, any constituents in that water would continue to be concentrated to greater concentrations with each cycle. Further, drought conditions often persist for weeks, if not months, so an additional two days worth of storage hardly seems adequate. Another potential option offered by CWLP was to reduce flow of water through the power plant. Droughts, however, typically occur in the summertime, when temperatures are high— precisely the time of peak power production and the greatest time of need for cooling of the power plant rendering this option impracticable.

E. CWLP should have anticipated and remedied this problem years ago.

Finally, Prairie Rivers Network would like to call attention to the fact that the problem of high concentrations of boron in the flue gas desulphurization blowdown wastewater should have been anticipated at the time additional air pollution control technology, such as the selective catalytic reduction system components, was installed on the Dallman units. CWLP was provided with enough information to be able to understand, prior to upgrading the air emissions control equipment, what had been released into the air and what would, after installation of the SCR's, be collected and disposed of in the wastewater. Further, the concentration of boron, along with many other pollutants, has been monitored on at least a monthly basis for Outfalls 003 and 004 to Sugar Creek since 1993. CWLP was equipped with the necessary information to be able to anticipate that boron concentrations in both the ash pond discharge and FGDS blowdown would exceed the water quality standard and should have remedied this problem several years ago with a more sophisticated (and less environmentally damaging) solution than dilution.

CERTIFICATE OF SERVICE

I, Traci L. Barkley, the undersigned, hereby certify that I have served Prairie Rivers Network's COMMENTS OPPOSING PROPOSED SITE-SPECIFIC BORON STANDARD FOR CWLP & SMSD in R2009-008 upon:

Mr. John T. Therriault
Assistant Clerk of the Board
Illinois Pollution Control Board
100 West Randolph Street
Suite l1-500
Chicago, Illinois 60601

via electronic filing on January 29th, 2009; and upon the attached service list by depositing said documents in the United States Mail, postage prepaid, in Chicago, Illinois on January 29th, 2009.

Respectfully Submitted,

Traci L. Barkley
Water Resources Scientist
Prairie Rivers Network
1902 Fox Drive, Suite G
Champaign, Illinois 61820
(217) 344-2371

SERVICE LIST- R2009-008
January 29th, 2009

Marie E. Tipsord
Illinois Pollution Control Board
James R. Thompson Center
100 W. Randolph, Suite 11-500
Chicago, Illinois 60601

Michael D. Mankowski
Assistant Attorney General
Office of the Attorney General
Environmental Bureau
500 South Second Street
Springfield, IL 62706

Joey Logan-Wilkey, Assistant Counsel
Illinois Environmental Protection Agency
1021 North Grand Ave. East
P.O. Box 19276
Springfield, IL 62794-9276

Katherine D. Hodge
Hodge Dwyer Zeman
3150 Roland Avenue
P.O. Box 5776
Springfield, Illinois 62705-5776

FGD Purge ZLD

Reality At Enel

ENERGY IN TUNE WITH YOU.

Presentation By

Devesh Mittal |&| Greg Mandigo

McIlvaine Webinar November 12th 2008

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* * * * * PC #4 * * * * *

ZLD
Zero Liquid Discharge

"Concentration"

A Solution To Pollution!

ZLD A Viable Reality

ENEL, Italy Locations

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ZLD A Viable Reality

Aquatech

ENEL Location	Power MW (Wet FGD)	ZLD Cap. in GPM	Date Stopped Discharge
Brindisi	4 x 660	BC 2 x 300 FC 1 x 77	August 2008
Fusina	2 x 330 2 x 165	BC 2 x 150 FC 1 x 55	May 2008
Sulcis	1 x 240	BC 1 x 55 FC 1 x 22	June 2008
LaSpezia	1 x 600	BC 1 x 66 FC 1 x 27	November 2008 (Under Testing)
Torrevaldaliga	3 x 660	BC 2 x 155 FC 1 x 62	December 2008 (New Power Plant)

BC = Brine Concentrator FC = Crystallizer GPM = Gallons / Minute MW = Megawatt

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Typical FGD Purge WW

pH:	6.5	–	8.0	
Temperature:	100	–	110	°F
Hardness (Ca + Mg):	17,500	–	28,000	ppm $CaCO_3$
Sulfates:	3500	–	7000	ppm
Chlorides:	10,000	–	30,000	ppm
Total dissolved solids:	20,000	–	50,000	ppm
COD / BOD:	None	–	1500	ppm *
Trace Heavy metals:	10	–	100	ppm
Selenium:	0.5	–	15	ppm
Boron:	25	–	650	ppm
Ammonia Nitrogen:	5	–	35	ppm
Nitrate Nitrogen:	25	–	500	ppm

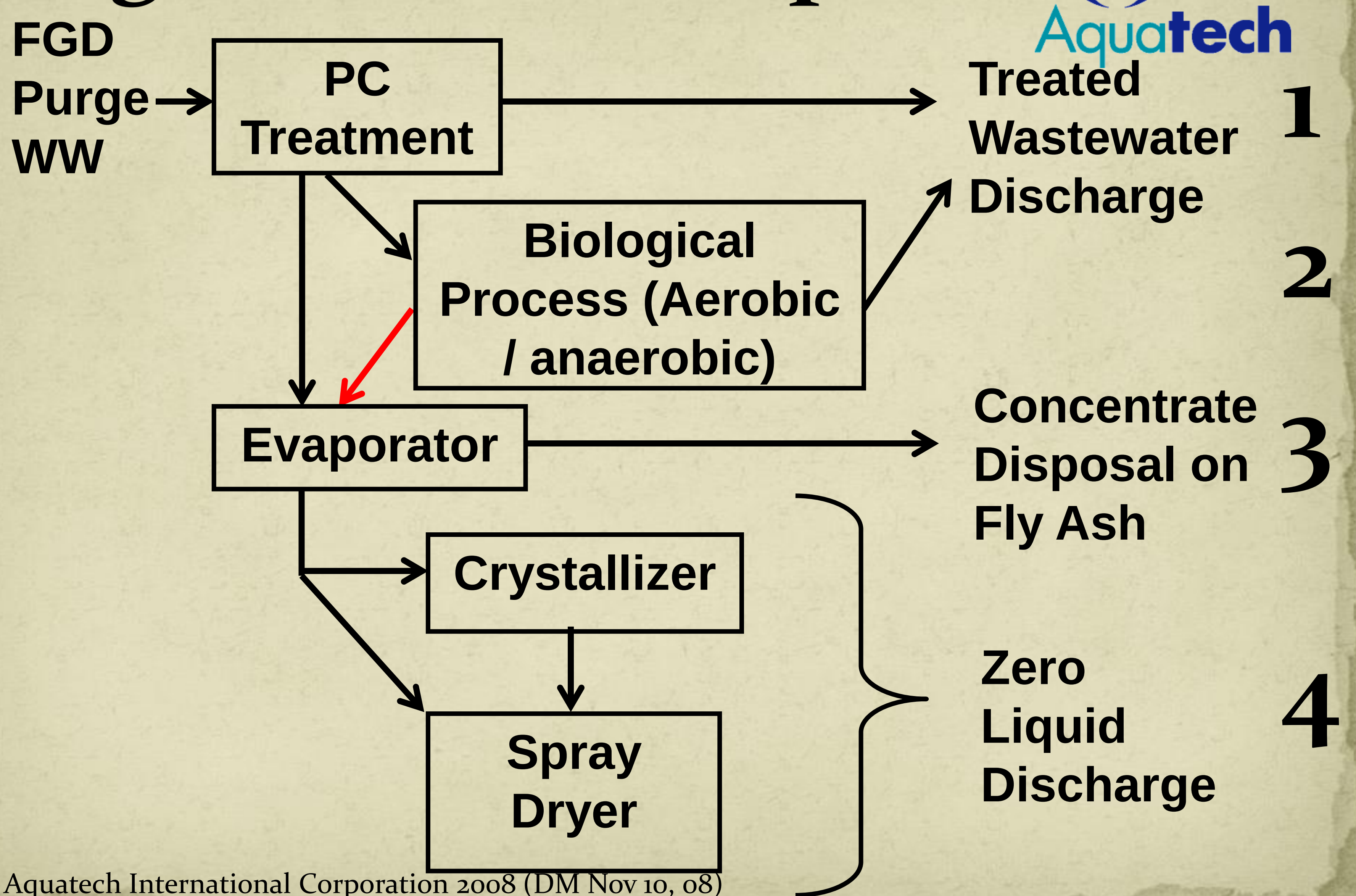
*dependent on usage of buffers like DBA or Formic acid

Key Purge WW Design Variables

Aquatech

- Quality of coal
- Make up water source
- Scrubber design
- Scrubbing agent composition
- Scrubber additives (DBA, other organics)

Purge Treatment Options

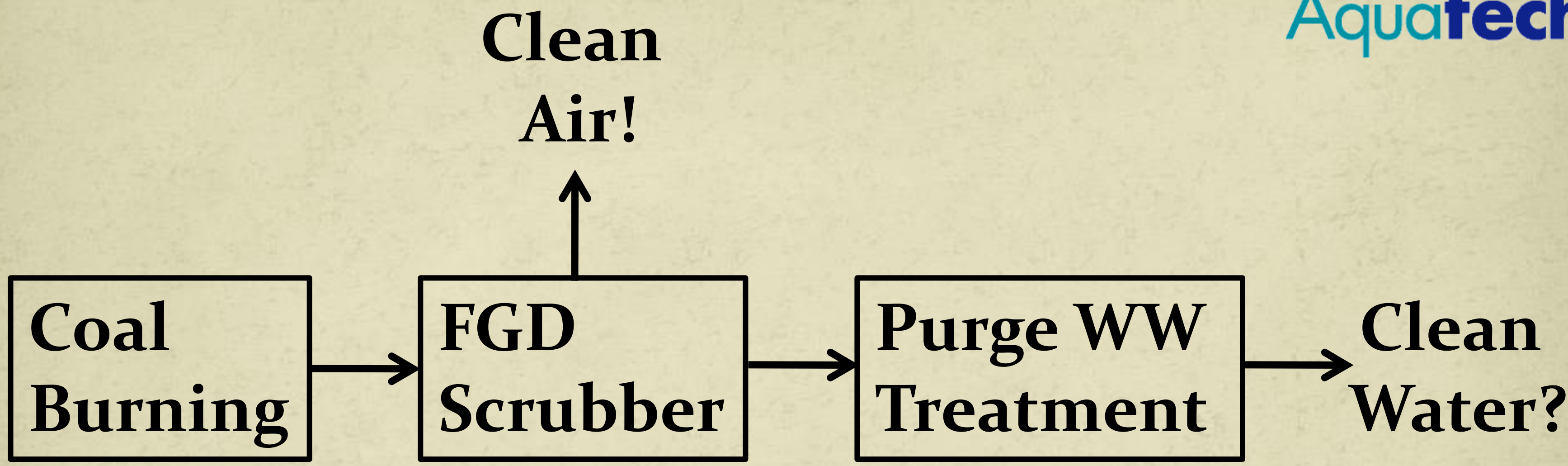


FGD Purge Treatment In USA So Far

Aquatech

- Physical Chemical (Well Established)
  - Calcium Sulfate desaturation & clarification
  - Sulfide precipitation & clarification
- Biological treatment (Developing)
  - Selenium & heavy metal reduction
  - BOD & or N reduction

Clean Air! Clean Water?



- Is this <u>really</u> a complete solution?
- <u>Limited number</u> of constituents <u>reduced</u>
- <u>High salinity still being discharged</u>
- What about tightening regulation?

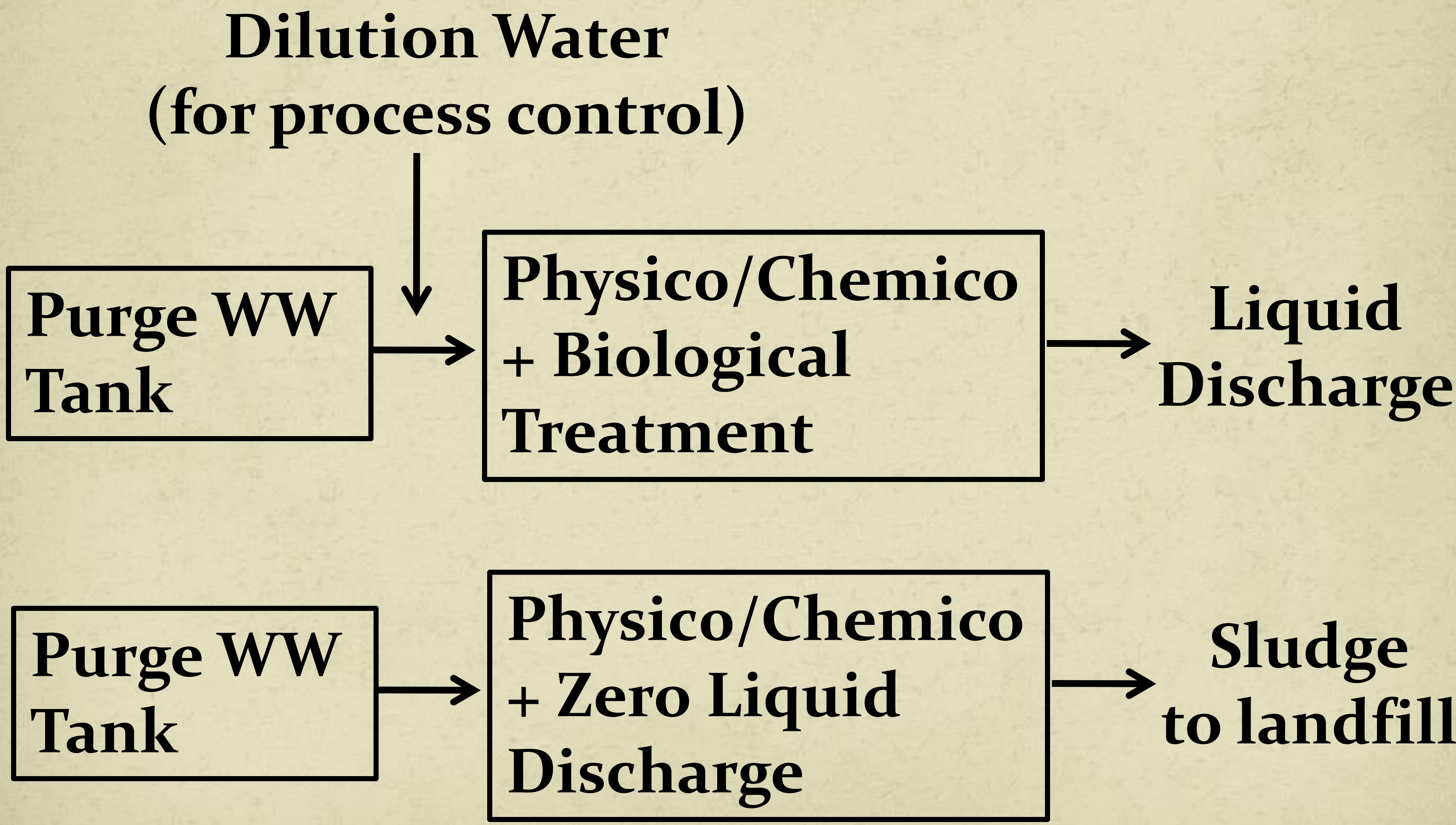
Troubling Constituents

Aquatech

Constituent	Key Issue / Discharge Limit	Impact by physical chemical or biological treatment
Calcium	Scaling	Reduction by precipitation
Sulfate	Scaling w/hardness	Settling in clarifier w/hardness
Chloride	Corrosion	No reduction
TDS	Discharge issues	No reduction; likely to increase
Mercury	Limits getting stringent i.e. in ppt	Reduction possible; requires elaborate process including ion selective ion exchange resins
Selenium	Limits getting stringent i.e. ppb	Selenites can be reduced in physical chemical; lower limits require biological treatment
Nitrates	Some cases have seen 3 ppm total nitrogen	Requires nitrogen reduction via biological process; difficult in high TDS environment
Trace metals	Site specific issues	Depends on the trace metal
Boron	Site specific issues	No reduction

TDS = total dissolved solids ppt = parts per trillion ppb = parts per billion

Dilution Vs. Concentration



Myths Against ZLD

- Technology does not exist
- Existing technology
  - Does not work
  - Is extremely expensive
  - Is difficult to operate

Fact Check!!!

- Technology does ~~not~~ exist
- Existing technology
  - Does ~~not~~ work
  - Is extremely ~~expensive~~ cost comparable to physico chemical & biological treatment
  - Is ~~difficult~~ straight forward to operate
- No liquid discharge; complete solution
- Process simplicity; elimination of biological treatment possible
- No specialty bugs or bacteria; doesn't require a biologist or biochemist to run the unit
- Higher operating reliability

ZLD Selection Criteria

- Corporate social initiative (ENEL)
- Permitting issues
  - Discharge not allowed
  - Discharge limits stringent or not achievable by physical chemical or biological treatment
- Waste water characteristics
  - Variation due to variety of coal used
  - Constituents not treatable by other processes e.g. boron
- Cost of waste water treatment
  - Cost comparison with biological treatment
  - Capacity of waste water treatment unit

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ENEL Design Purge WW

Aquatech

Parameter as ppm	Brindisi	Fusina	LaSpezia	Sulcis	Torrevaldaliga
Suspended Solids	1 to 1.5%	1 to 1.5%	1 to 1.5%	1 to 1.5%	1 to 1.5%
Calcium, Ca	42,00	8,400	8,400	1,200	12,000
Magnesium, Mg	250	4,500	4,500	1,200	6,400
Sulfate, SO_4	11,900	10,900	10,900	24,500	17,700
Chloride, Cl	22,800	25,000	25,000	15,400	30,000
Nitrate, NO_3	300		300		300
Fluoride, F	25		350		1,000
Alkalinity, HCO_3	80		600		600

- Each power plant uses multiple sources of coal; worst value from several coal values reported above for each parameter
- Each ZLD plant designed for over 30,000 ppm TDS in feed

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Brindisi Pictures

Aquatech

Lime Clarifiers

Brine Concentrator

Crystallizer

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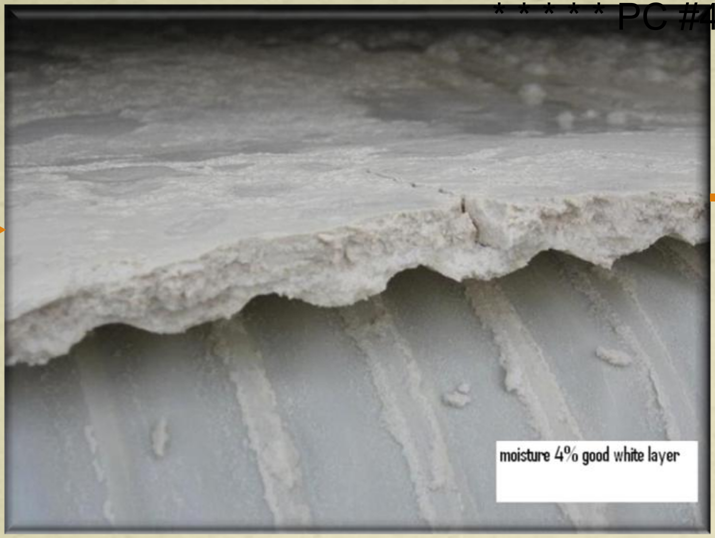
Brindisi Pictures

Aquatech



Belt Press

Sludge Handling

Sludge For Disposal

Aquatech

Fusina

Sulcis

LaSpezia

Torrevaldaliga

ENEL Plant Operation

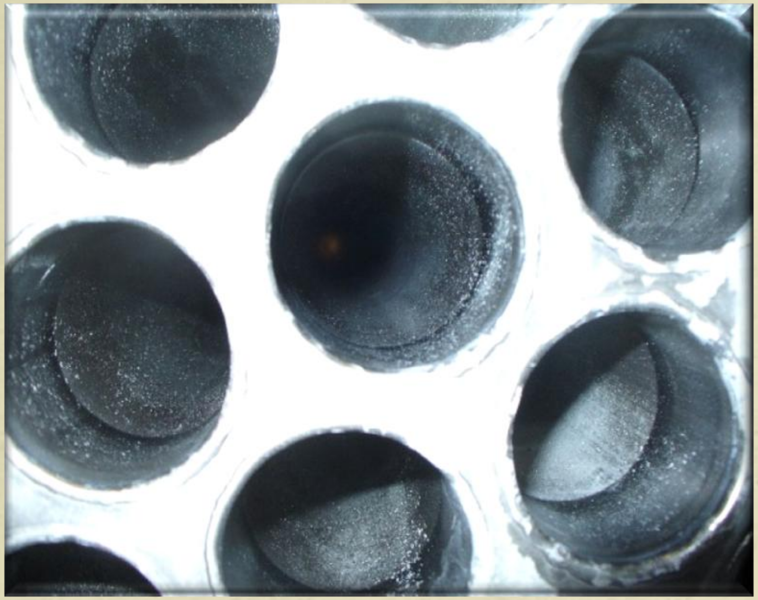
- Coal
  - Imported from several countries
  - Variability in purge waste water
- Evaporator
  - Operated in seeded slurry mode
  - WW feed variability managed by local operators
- Sludge
  - Calcium carbonate sludge recycled to scrubber
  - Evaporator sludge
    - Approx. 85% plus dry solids
    - Non classified; disposed through authorized agency
    - Passed leachability (TCLP)
- Distillate recycled to scrubber and cooling tower

ZLD Design

- Requires prior experience
- Careful consideration of waste water data
- Proper selection of metallurgy
- Proper selection of operating parameters i.e. pH, concentration factors, etc.
- Design safety margin important

**Once properly designed,
operating issues are straight forward**

ENEL Operation



- Clean tubes after 6 months of operation
- Equipment operated by local operators
- Operating parameter controls already set

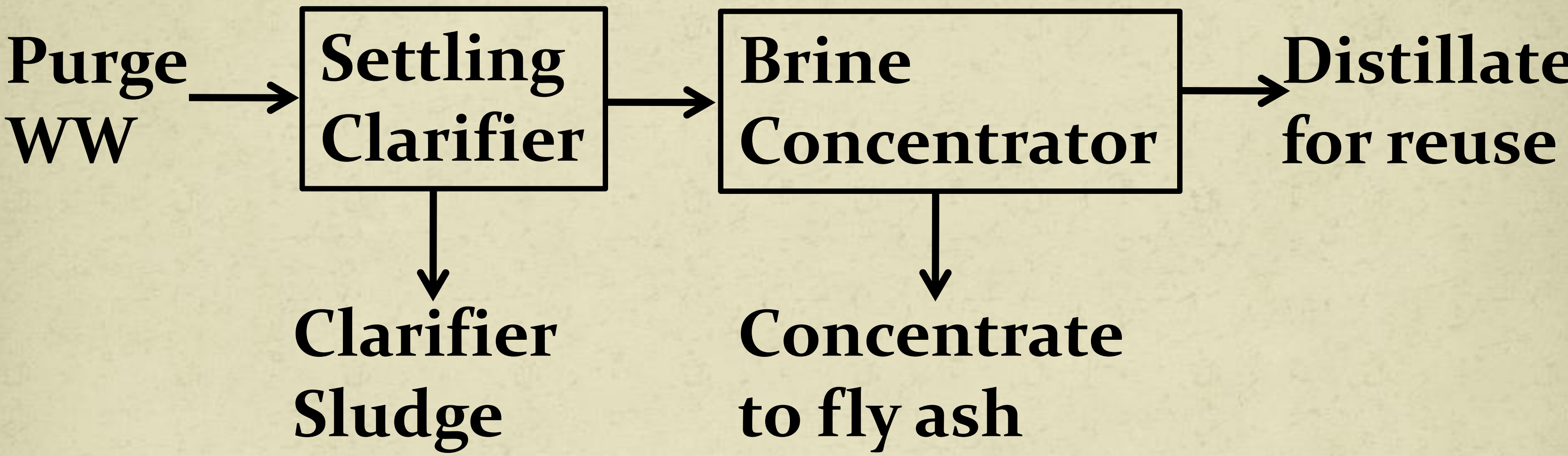
Aquatech's Other Coal Connections

- Aquatech evaporators in IGCC units operating for 20 to 25+ years
  - North Dakota Gasification (Lurgi Process)
  - Tampa Electric (Texaco Process)
  - Demkolec IGCC (Shell Process)
- Upcoming IGCC projects
- CO_2 capture retrofits or new units
- Coal plant cooling tower ZLD

2 x 30 gpm Going On Line 2009
Kansas City Power & Light

Aquatech

KCPL System


Purge WW
Settling Clarifier
Brine Concentrator
Distillate for reuse
Clarifier Sludge
Concentrate to fly ash

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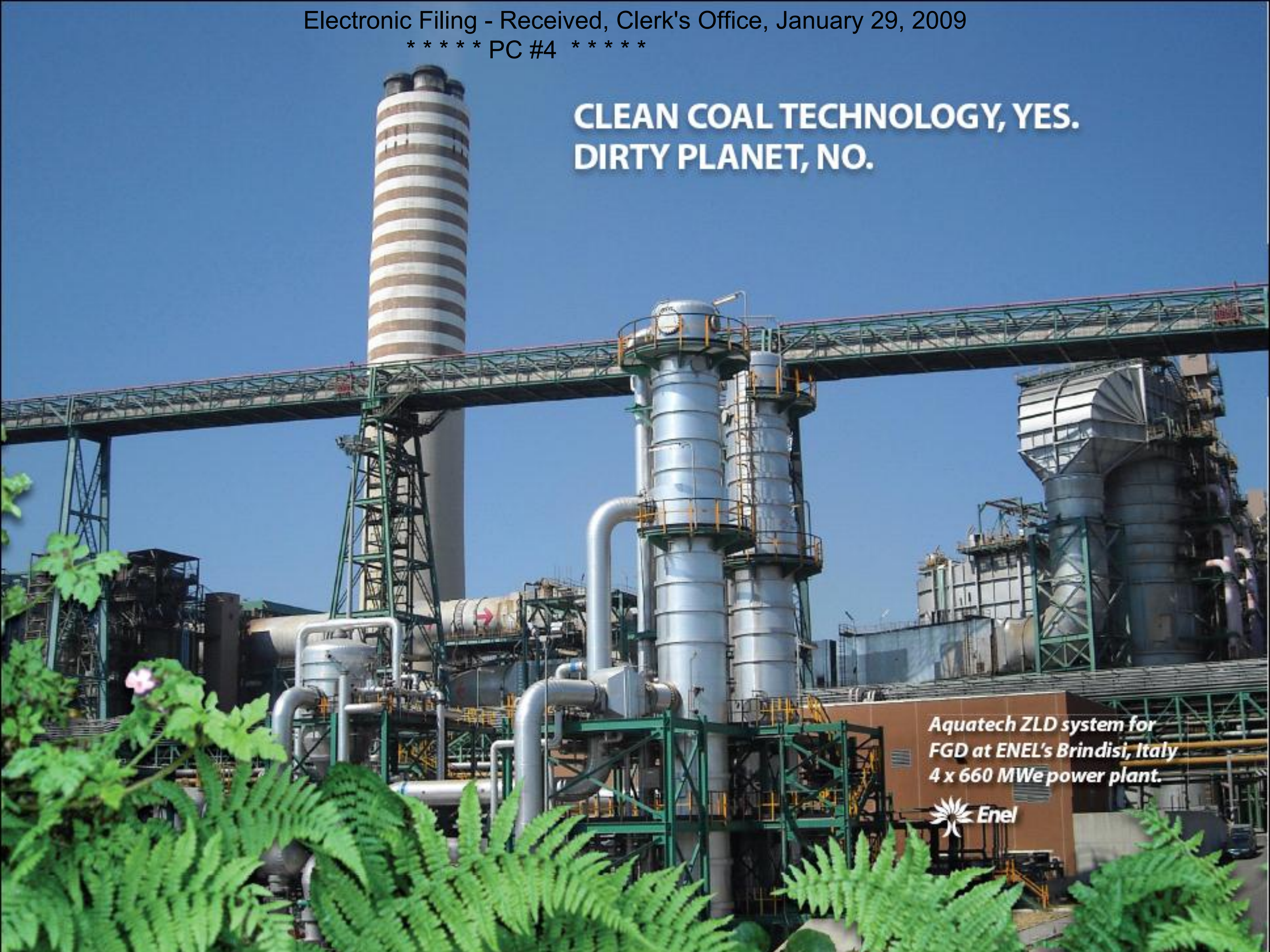
KCPL Design Purge WW

Aquatech

pH	6.0	
Suspended solids	30,000	ppm
Calcium	4,250	ppm
Magnesium	950	ppm
Sodium	590	ppm
Potassium	25	ppm
Iron	15	ppm
Chloride	10,000	ppm
Sulfate	1,320	ppm
Nitrate	90	ppm
Fluoride	12	ppm
Silica	28	ppm
Alkalinity	280	ppm


CLEAN COAL TECHNOLOGY, YES.
DIRTY PLANET, NO.
Aquatech ZLD system for
FGD at ENEL's Brindisi, Italy
4 x 660 MWe power plant.
Enel

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FGD Purge ZLD

"Truly Part Of" Clean Coal

Additional Information

- Devesh Mittal 281.794.3113 or mittald@aquatech.com
- Aquatech Technical Material
  - International Water Conference Papers
    - IWC 06 Hoskin & Mittal
    - IWC 06 Bjorklund
    - IWC 07 Mandigo
    - IWC 08 Donadono & Rao
  - Project profiles
  - Technical write ups and flow diagrams
- Project specific design assistance

Powergen 2008
Floor Give Away Sponsor

Aquatech

Make or model of the car is yet to be declared. Above from 2007

Booth # 1412

PROJECT PROFILE SERIES #39

Coal Fired Power Plant Achieves ZLD for FGD Wastewater

The Facility

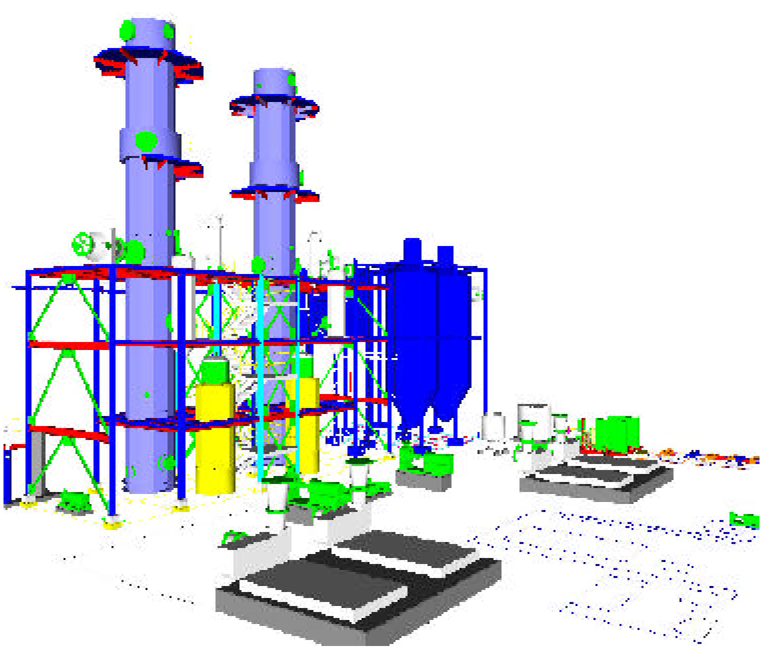
Illinois' City of Springfield's Dallman Power Station's three coal-fired units and soon to be installed fourth unit, are equipped with flue gas desulfurization (FGD) systems (scrubbers) to control sulfur dioxide (SO_2) emissions.

The Problem

A sharp increase in boron concentration in the FGD wastewater required that The City of Springfield Office of Public Utilities and the Illinois Environmental Protection Agency develop a boron mitigation strategy to remove the boron from the waste streams at the power generation facility. This meant including a new FGD wastewater treatment (Zero Liquid Discharge or ZLD) plant for the power plant. The elevated boron levels are caused from ammonia carryover due to the Dallman Unit's Selective Catalytic Reduction (SCR) systems' nitrogen removal process.

The Solution

In December 2005, Aquatech received a ZLD contract for the mitigation of boron from the FGDWastewater generated at the Dallman Power Plant from the City of Springfield in Illinois.



Under this contract Aquatech will provide a ZLD system comprising of 2 x 60% Brine Concentrators (total treated flow of 240 gpm) followed by spray dryers that will treat blowdown from the FGD scrubbers installed at the coal fired power plant. At full load, the ZLD facility will treat wastewater generated by the existing unit and the new one under construction.

The ZLD Evaporation System is a fully integrated automated system incorporating a mechanical vapor compression falling film seeded slurry brine concentrator and a spray dryer system. The high purity distillate produced in this system will be used as makeup to the cooling tower or boiler feed water treatment system.

The ZLD System is designed for automatic steady state operation and will minimize operator attention. The materials of construction have been selected to resist corrosion and ensure a long plant life.

Features and Benefits of Aquatech Brine Concentrator Design in FGD Service

Optimized Materials of Construction for FGD service FGD Blowdown contains elevated levels of calcium and magnesium chloride and other similar salts. As these salts concentrate in an evaporator they become increasingly corrosive because of which the evaporator materials of construction need to be upgraded to expensive materials such as titanium and nickel based alloys. Aquatech has provided an innovative design in these brine concentrators. The design innovations limits the concentration of chlorides within levels that allow the use of more conventional materials of construction.

Optimized Vapor Compressor for FGD Service Another benefit of limiting the chloride concentration in the brine concentrator is on the selection of vapor compressor. The vapor compressor selected is less likely to be subjected to corrosive conditions and vibration problems that could exist in systems deployed in FGD service.

Superior Brine Distribution System Aquatech's proprietary dual perforated plate distribution system has a proven track record of superior flow distribution of brine to the tubes practically eliminating chances of tube plugging. Unlike

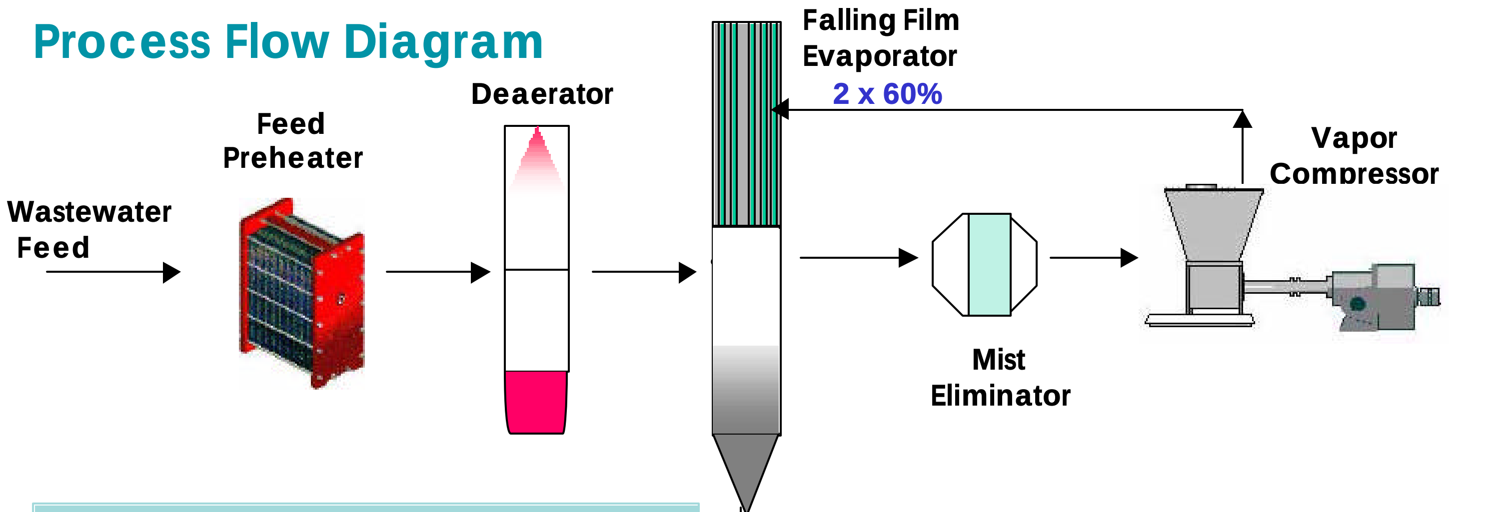
Aquatech International Corporation
One Four Coins Drive; Canonsburg, PA 15317 USA
T: 724-746-5300 F: 724-746-5359 aic@aquatech.com www.aquatech.com

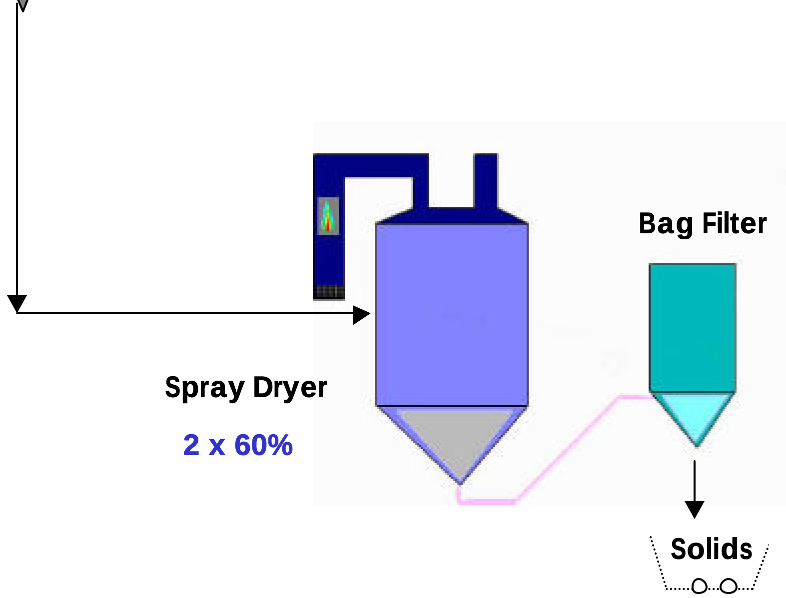
individual tube inserts which routinely plug up in high suspended solids brines like FGD blowdown, Aquatech's distributor assures uniform flow of brine across the entire tube bundle and down the inside wall of each tube.

Superior Mist Elimination System Aquatech's design include mist eliminators that prevent droplets containing concentrated chloride salts from passing into the vapor compressor thus preventing pitting corrosion of compressor impeller and suction expansion joints. Aquatech's unique design of the mist eliminators provides easy access and cleaning of internal sump mist eliminators eliminating the need for complicated shutdown of evaporator equipment and the need to install temporary scaffolding inside the sump.

Aquatech employs a proprietary two-stage external mist eliminator using horizontal flow chevrons for the brine concentrator which is very efficient at eliminating brine droplets which become entrained in the water vapor. The distillate produced typically contains less than 10 ppm nonvolatile solids, even with very high TDS levels in the evaporator sump. In Aquatech's brine concentrator design for FGD service, the efficiency of the mist eliminator combined with the low chloride salt concentration maintained in the evaporator sump and high alloy construction of the vapor compressor plus the ability to rinse the compressor rotating assembly with water during operation means that corrosion potential on the vapor side of the evaporator is practically eliminated. Inspection and access to the external type mist eliminator is very straightforward as the entire mist eliminator assembly is directly accessible from the platform manway.

Process Flow Diagram





Design Feed Chemistry

Flow Rate, gpm	200
Chemical Composition, m/l	
Calcium, as Ca	8702
Magnesium, as Mg	1764
Barium, as Ba	1
Boron, as B	881
Sodium, as Na	159
Potassium, as K	53
Iron, as Fe	44
Bicarbonate, as HCO_3	300
Chloride, as Cl	15000
Sulfate, as SO_4	3525
Nitrate, as NO_3	98
Fluoride, as F	35
Total Dissolved Solids, mg/l	30,561
Total Suspended Solids, mg/l	206
Total Oil and Grease, mg/l	<1
pH	7.3

PROJECT PROFILE SERIES # 51

ENEL Power, Italy – Brindisi Project – ZLD Plant for FGD Wastewater Treatment

The Facility

The Brindisi Sud Power Plant is equipped with four coal-fired units each of 660 Mwe capacity. Units normally fire imported coal with < 1% Sulphur. The flue gases are treated sequentially by SCR-DeNOx with ammonia as reagent, High efficiency ESP to remove fly ash and wet limestone gypsum forced oxidation DeSOx. Each unit is equipped with a 2x50% DeSOx lines each with a prescrubber for final dedusting and gas saturation and an absorber. The blow down from both prescrubber and absorber along with other wastewaters are sent to a Wastewater treatment plant where in the first stage lime and sodium sulphide are added to remove metals; in the second stage ferric chloride is added to remove suspended solids and in third stage hydrogen peroxide us added to remove oxidizing agents. The prescrubbers are fed with sea water and at the WWTP the brine was treated and discharged into the Adreatic Sea.

The Problem

Wastewaters from FGD treatment plant can no longer be discharged into the sea due to tough Italian and EU environmental regulations. In order to overcome this major environmental problem, ENEL decided to feed the prescrubbers with fresh and recirculated waters and install the Zero Liquid Discharge (ZLD) plant so that no industrial wastewater discharges are allowed by the entire power plant.

The Solution

To overcome the problem, ENEL selected the Softening –Evaporation – Crystallization (SEC) process to treat the wastewaters and reuse/conserve fresh waters. Aquatech supplied, installed, commissioned the ZLD plant as an EPC contractor with local associates.

The SEC plant comprises of 2X50% Softener Clarifiers (calcium reduction by soda ash dosing), 2x50% Falling film type Brine Concentrators (each equipped with two vapor compressors operating in series), 1x100% Crystallizer (equipped with Thermocompressors) and 2x50% Belt Filter Presses. The plant also includes several chemical dosing systems, storage tanks, pumping systems, electrical works (MCC, cable trays, cabling etc), Controls & Instrumentation.

The Zero Liquid Discharge (ZLD) plant is a fully integrated automated system. The Brine Concentrators operate in seeded slurry mode. Each Brine Concentrator is equipped with external mist eliminator for ease in maintenance. The Crystallizer operates in forced circulation method.

The industrial grade soft water and high purity distillate produced in the system will be used in the main power plant.

Aquatech

Aquatech International Corporation
One Four Coins Drive; Canonsburg, PA 15317
T: 724-746-5300 F: 724-746-5359 aic@aquatech.com www.aquatech.com

aqua-chem ICD
Industrial Concentration & Desalination

PROJECT PROFILE SERIES # 51

DESIGN FGD WASTEWATER ANALYSIS

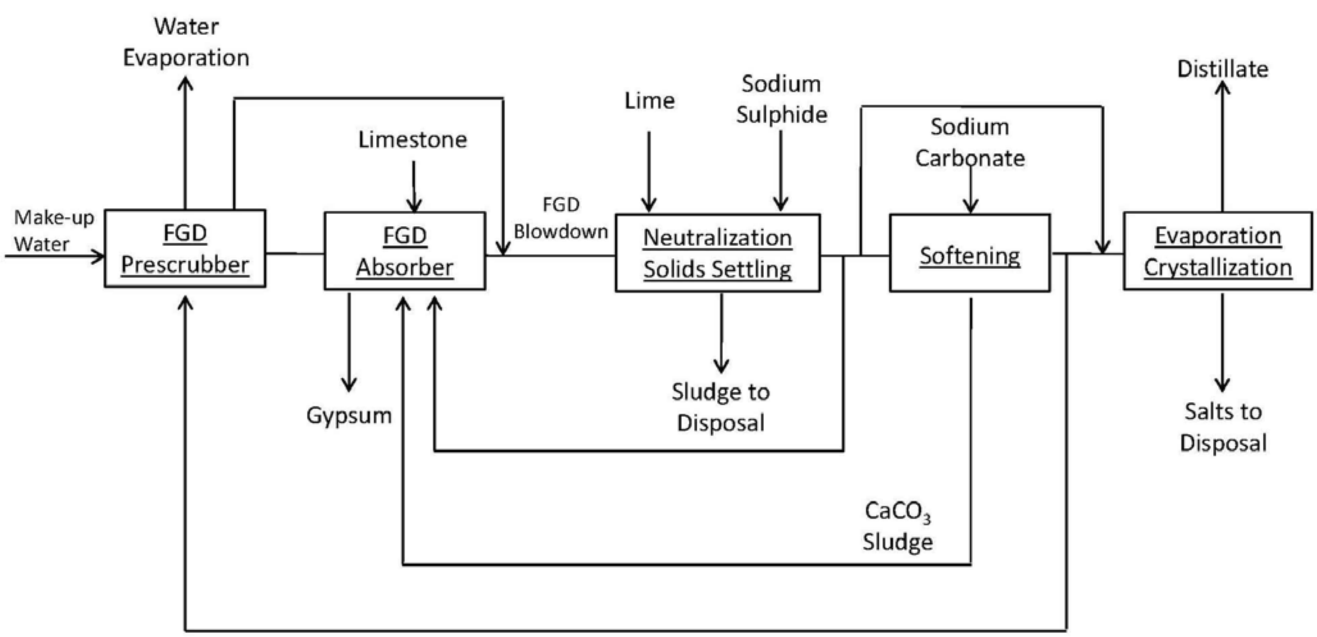
Design Flow 140 M3/hr
(PT Plant)

Calcium: .... 4200 ppm
Magnesium: ……………200 to 250 ppm
Potassium .... Balance
Sodium: .... 1757 ppm

TSS .... 80 ppm
pH................................ 9.5 to 10

Bicarbonate .... 80 ppm
Phosphates................. 25 ppm
Chlorides .... 22800 ppm
Nitrates .... 300 ppm
Sulfate…………………1700 ppm
SiO2 ……………………10 ppm

PROCESS FLOW DIAGRAM



Aquatech International Corporation
One Four Coins Drive; Canonsburg, PA 15317
T: 724-746-5300 F: 724-746-5359 aic@aquatech.com www.aquatech.com

aqua-chem ICD
Industrial Concentration & Desalination

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Aquatech

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Industrial Concentration & Desalination

Zero Liquid Discharge System

Overview

The Aqua-Chem ICD Zero Liquid Discharge System is a fully integrated automated system incorporating a mechanical vapor compression brine concentrator, a forced circulation crystallizer, and solids dewatering. High purity distillate produced in this system can be used for cooling tower or boiler makeup water.

The Aqua-Chem ICD Zero Liquid Discharge System typically follows a reverse osmosis (RO) preconcentrator. High TDS and saturation in low solubility scaling salts such as calcium sulfate ($CaSO_4$) and silica (SiO_2) limit the percentage of water which can be recovered by an RO system. Feedwater saturated in $CaSO_4$ and/or SiO_2 is also very difficult to concentrate in a normal evaporator but can be handled in the Aqua-Chem ICD brine concentrator. The process, also called seeded slurry evaporation, involves establishing and maintaining a slurry of calcium sulfate seed crystals in the circulating brine in the evaporator. With careful thermal and mechanical design, the SiO_2 and $CaSO_4$ will precipitate preferentially on the recirculating crystals instead of on the tubes. The brine concentrator is capable of concentrating the wastewater to near saturation in the sodium salts without scaling the heat transfer tubes.

The remaining water is evaporated in the forced circulation crystallizer. This evaporator easily handles the crystallization of the remaining salts regardless of the exact chemical analysis. The salts are removed as a cake by a (filter press, centrifuge).

The Aqua-Chem ICD Zero Liquid Discharge System is designed for automatic steady state operation and will require little operator attention. The materials of construction have been selected to resist corrosion and ensure a long plant life. The system is very reliable. The pumps and compressor typically operate years without significant problems, given periodic maintenance typical for rotating equipment. Almost any problem can be fixed in a day. The system is designed to minimize scaling of the heat transfer surfaces; however, it is also designed to operate in a slightly fouled condition, so normal fouling or scaling will not affect the design capacity of the unit. Chemical cleaning of the system is typically required once or twice per year.

Process Description

The feed is acidified with H_2SO_4 to a pH of 5.5 which converts bicarbonate to dissolved CO_2 for removal in the deaerator. The bicarbonate is removed to prevent scaling of the brine concentrator tubes with calcium carbonate ($CaCO_3$). A small amount of scale inhibitor is metered into the feed to avoid scaling in the feed/distillate plate heat exchanger. Depending on the amount of calcium in the feed, the anti-scale may be reduced or eliminated.

The feed/distillate heat exchanger, a plate and frame type with titanium plates, preheats the feed with outgoing hot distillate. The heated feed flows to the deaerator to remove dissolved carbon dioxide and oxygen, to minimize corrosion in the system. Aqua-Chem ICD uses a flashing deaerator which does not utilize packing, thereby avoiding plugging problems. The feed is sprayed into the pressurized, barometric half of the deaerator which further heats the feed with low pressure evaporator vent vapors. The feed then flashes into the low pressure portion of the deaerator. A small fraction of water from the feed is vaporized, along with the dissolved carbon dioxide and oxygen, which are virtually eliminated by this step. Typical dissolved oxygen content in the deaerated feed is 10 ppb.

The feed then flows to the brine concentrator vessel. Calcium sulfate scale is managed in this vessel by proper feed pretreatment and by providing adequate seed crystal surface area dispersed homogeneously in the brine slurry. The seed crystals prevent supersaturation extremes and promote crystal growth rather than scaling on the heat transfer surface.

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One-Four Coins Drive; Canonsburg, PA 15317 USA t) 724 746 5300 f) 724 746 5359

The seed crystals are added as gypsum to the seed makeup tank at startup to establish the circulating slurry. As the brine is concentrated and some is pumped to the crystallizer, seed crystals are replenished by natural generation from calcium and sulfate ions in the incoming feed water. A seed thickening tank is provided to recycle seed crystals back into the brine concentrator if the natural seeding level is too low. A $CaCl_2$ injection system is provided to add Ca+2 directly into the feed line if the incoming Ca+2 concentration is too low. Both of these systems are used to maintain adequate seed crystal concentration in the brine concentrator.

The brine concentrator vessel is designed with a long bottom channel to provide sufficient residence time for crystal growth. A vapor separator with mist eliminators is used to remove entrained droplets of brine from the vapor before it flows to the compressor. The mist eliminators are periodically sprayed with hot distillate to dissolve any accumulated solids.

Vapor generated in the brine concentrator flows to a mechanical compressor, which increases its saturation pressure and temperature. Then the compressed vapor flows to the shell side of the brine concentrator in lieu of external heating steam. The vapor is condensed on the outside of the tubes, transferring heat to the circulating brine on the tubeside. Condensed vapor (distillate) is pumped out of the system. Some of the distillate is sprayed into the compressor discharge duct to desuperheat the compressed vapor.

The brine concentrator is designed with a very low delta-T (temperature difference between the heating medium and the boiling brine) and a high recirculation rate. The two main benefits are reduced scaling rate and a lower compressor power requirement. Energy economy is maximized by utilizing distillate and vent stream heat. The system is designed for low make-up steam at steady state operation.

The brine is concentrated to approximately 25% total solids in the brine concentrator. To maintain a solids balance in the system, part of the concentrated brine is continuously pumped from the brine concentrator to the forced circulation crystallizer.

Recirculated brine is pumped through the forced circulation heat exchanger where it is heated with steam from the brine concentrator to above its normal boiling temperature. Boiling of the brine in the heat exchanger is suppressed due to sufficient static head. Boiling in the heat exchanger would cause scale formation on the heat transfer surface. The heated brine then enters a flash tank operating at a slightly lower pressure, causing flash evaporation of water and formation of salt crystals in the brine. High recirculation rates are used to keep the contact time on the heated surface low, reducing the scaling rate of the heat transfer surface.

Once every eight hours the a batch of slurry is discharged from the crystallizer to the filter press feed tank. This slurry is fed to the filter press, which separates out the salt crystals as a cake. The liquid portion, saturated in dissolved salts, is returned to the forced circulation crystallizer. The salt cake is dumped at 8 hour intervals into a hopper for disposal. This sequence is manually initiated, and requires an operator to be present to assure that the plates have properly released the salt cake.

Vertical Tube Falling Film Evaporator (Brine Concentrator)

Falling film vertical tube evaporators use vertical tube bundles with brine evaporating from a thin film on the inside of the tubes. Brine is distributed in a thin film down the inside of the tubes. The brine absorbs heat from condensing water vapor on the outside of the tubes. The latent heat of vaporization transfers from the water vapor through the tube wall to the thin brine film on the inside of the tube. For every kilogram of water vapor that condenses, approximately one kilogram of water is evaporated from the brine film.

The vapor condensing on the tube bundle is primarily water vapor but can also contain air and other non-condensables. These non-condensables will stay in the vicinity of the tube walls and impede heat transfer unless swept away by sufficiently high vapor velocities. A vent on the evaporator body continuously removes the non-condensables to maintain high heat transfer coefficients and to prevent loss of driving force (differential temperature) through excess subcooling of the heating vapor.

The brine is introduced at the top of the vessel and flows in a downward direction as a falling film. The brine is uniformly and generously directed to the full circumference of each tube as a thin film. Because the recirculation rate is many times greater than the evaporation rate, only a small change in concentration occurs down the tube length as evaporation takes place. The recirculation rate is chosen conservatively to ensure that the heat transfer surface is well wetted and localized drying is not encountered.

A proprietary dual perforated plate distributor ensures that the liquid is evenly distributed to the tubes. The plates have holes larger than 13 mm and have been proven to be much less susceptible to plugging than other designs including individual weir inserts or swirler inserts.

Careful design eliminates areas where the solids and impurities may collect and impede liquid flow and heat transfer. Design features include large holes in the distribution system, sloped bottoms, and smooth entrance to pump suctions.

Mechanical Vapor Compression (VC)

Vapor compression is a highly efficient process using mechanical energy input to achieve evaporation and condensation. The fundamental difference between the vapor compression unit and the conventional evaporator is that the latent heat of vaporization is fully utilized in the VC evaporator. Since the evaporator also serves as the condenser, essentially all of the latent heat is recycled, with no rejection of heat to cooling water.

The evaporated vapor flows through the mist eliminator to the suction of the compressor. The compressor does work on the water vapor increasing the saturation pressure of the water vapor so that when it condenses, it does so at a higher temperature. The compressed vapor flows to the heating side of the evaporator. As it condenses, it transfers the latent heat of vaporization back to the liquid film on the tubeside.

The compression process produces discharge vapors that are superheated (i.e. hotter than the corresponding saturation temperature). Scaling, excessive fouling, and stress corrosion can occur if the superheated vapor is allowed to condense on the evaporator tube bundle. This scaling would occur as the sensible heat is transferred through the tube. To remove the superheat in the compressed vapor discharge, desuperheating water (in the form of distillate) is sprayed into the vapor stream. This distillate is very near the saturation temperature so latent heat is not removed from the vapor stream and can be used for the evaporation process.

A multi-stage centrifugal blower is used for the brine concentrator. It is coupled to a motor-driven gearbox. This type of compressor is very simple and easy to maintain. System turndown is achieved by the adjustment of the blower discharge damper valve. Turndown to 65% of rated capacity can be attained in this manner.

Control

The system is designed for automatic cascade control. Evaporation rate in the brine concentrator is based on an operator setpoint. The damper valve at the compressor discharge controls vapor flow to the brine concentrator based on the distillate flow rate out of the system. All other flow rates automatically adjust based on this setpoint. The feed rate is based on distillate outflow and brine level in the brine concentrator. Pressure (and indirectly temperature) in the brine concentrator is controlled by venting excess steam to the atmosphere or by allowing external steam into the system. The concentrated brine flow rate is remotely set based on feed and distillate flows. Operational parameters of system pressure, sump level, distillate level, and concentrate flow will be automatically controlled based on changes to the desired evaporation rate.

Operation

The system is designed for manual start-up and automatic operation. The feed chemistry should be monitored periodically. Sufficient safeguards and interlocks to prevent unsafe conditions or equipment damage are included in this design. When the system is shut down it is important to either keep the system pressurized with steam to keep oxygen out or drain and flush the system to remove the chlorides. Chlorides in the presence of oxygen will accelerate corrosion and reduce equipment life.

Maintenance

The required maintenance for this Aqua-Chem ICD Zero Liquid Discharge System is typical for commercial process equipment containing high quality industrial duty components. The unit's rotating equipment, such as pumps and compressors, require periodic adjustment, lubrication, and servicing of components such as seals. Instrumentation was specifically chosen to be durable and trouble free, but will require periodic adjustment and recalibration. If recommended spare parts are kept on hand and a preventative maintenance program is implemented, then the net availability (operating factor) can be expected to exceed 95%. The required maintenance procedures, recommended spare parts, and recommended preventative maintenance program will be provided by Aqua-Chem ICD.

Washing

The heat transfer surface has been designed to operate at capacity with lightly scaled heat transfer surfaces. An occasional manual adjustment of the compressor valve will maintain the system capacity as the evaporators slowly scales and loses performance. When this valve has been fully opened and the necessary capacity can no longer be maintained, a chemical wash will be required to restore performance. A complete chemical cleaning procedure will normally take between 12 and 24 hours. The evaporators are normally cleaned by recirculating a hot 10% EDTA solution (diluted Nalco 760 for example) with the recirculation pumps. The cleaning solution is injected into the recirculation line. The solution is maintained hot (70°C) by using a small amount of steam flow through existing controls. Cleaning frequency for an evaporator of this type is typically once or twice per year.

It may be economical to hydroblast prior to cleaning with EDTA. This reduces the amount of EDTA required. We recommend a professional hydroblast crew do this work. Two 600 mm manholes on the top channel facilitate easier distribution plate removal and tube blasting.

Materials of Construction

Due to the relatively high chloride content the major vessels wetted materials are 6% molybdenum stainless steel such as 254 SMO or AL6XN. Tubes are titanium grade 2. Other materials used for brine service include fiberglass, CD4MCu, Hastelloy C, and 316L Stainless Steel as applicable. Use of these materials will assure equipment life beyond 20 operating years.

Spare Parts

Installing spare pumps in brine service would lead to stagnant areas and potential corrosion. Considering the high reliability of these pumps, it is better not to install spares but keep shelf spares. In the event a pump replacement is necessary, the feed storage tank would be used to collect the feed flow as it would be when the unit was shut down for cleaning. Upon startup the excess capacity designed into the unit will process the stored feed.

Raw Water Treatment

Ion Exchange

Membrane Processes

Recycle/Reuse

Zero Liquid Discharge

Industrial Concentration

Desalination

Aquatech

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* * * * * PC #4 * * * * *

Performance Excellence & Technology Leadership

Aquatech International Corporation, a leading supplier of industrial water and wastewater treatment systems and services located in Canonsburg, Pennsylvania in the USA, has provided Technology Leadership and Performance Excellence to the industry since 1981.

Backed by cutting edge technologies and supported with offices worldwide, Aquatech is well suited to be your preferred partner for optimal water and wastewater systems, a fact well demonstrated at thousands of operating systems in 45 countries.

Aquatech is a Full Scope company offering solutions from Concept to Commissioning and Troubleshooting in:

- **Power Generation**
- **Petrochemical**
- **Fertilizer**
- **Automotive**
- **Refineries**
- **Chemical**
- **Pulp & Paper**
- **Steel**
- **Electronics**
- **Pharmaceutical**
- **Semiconductor**
- **Food & Beverage**


Canonsburg Plant

Aquatech provides a full spectrum of water and wastewater treatment. Whether the feed source is Surface Waters, Well, Sea or a Wastewater Stream, Aquatech offers the expertise and experience to purify it to your industry's specific need-- for cooling tower makeup or boiler feed, process hosts or electronics grade.

Aquatech offers a strong product portfolio in optimal treatment systems customized to satisfy specific needs for a project. Whether the factors governing project requirements are process or regulatory, Aquatech provides the products and technologies to offer a cost-effective treatment scheme from pretreatment to zero liquid discharge or a combination.

Aquatech can be your single source supplier, offering one or several technologies for an optimal system configuration suiting specific project requirements, or combining select processes to recycle waste and offer a zero liquid discharge facility.

As a designer and supplier of water and wastewater treatment systems and services worldwide, Aquatech has developed an unparalleled global sourcing capability providing our customers with the same unmatched quality and maximum value through elimination of non-value added expenses.

Aquatech's highly trained field service engineers, located strategically in different geographical areas around the globe, ensure quality service in a timely and expeditious manner to help us realize our core value of Customer Satisfaction.

A T E C H N O L

Pretreatment

Regardless of the feed source – Surface Water, Well Water, Sea Water or Wastewater – Aquatech provides any of the following processes or a combination to make it suitable for the downstream processes:

Pretreatment Processes

- Filtration (Pressure & Gravity):
  - Media Filtration
  - Activated Carbon
  - Iron Removal
  - Mill Scale Removal
- Chemical Feed Systems
- Clarification:
  - Turbidity Removal
  - Softening
- Oxidation
- Sludge Handling:
  - Thickener
  - Filter Press

Ion Exchange

Aquatech offers expertise and experience in providing different types of ion exchange processes. As a Licensee of UPCORE™ packed bed ion exchange technology, Aquatech has provided some of the largest ion exchange installations in the world.

Ion Exchange Processes

- Water Treatment
  - UPCORE™
  - Split Flow Counter Current
  - Co-Current
  - Layered Bed
- Condensate Polisher
  - External Regenerated
  - Powdered Resin
  - Amine Cycle
  - Sodium Zeolite
  - Oily Condensate
- Specialty Applications
  - Glycol Purification
  - Brine Purification
  - Metals Removal
  - WAC Softening

Membrane Processes

Aquatech provides a complete range of membrane processes. In addition to conventional reverse osmosis, Aquatech offers systems incorporating HERO™ technology. A HERO™-based system can tolerate silica levels in excess of 2000 ppm in reject and operates at recoveries exceeding 90%. This, coupled with its tolerance to biological and organic fouling, makes systems incorporating HERO™ the technology of choice for difficult-to-treat water sources.

Membrane Processes

- Microfiltration
- Ultrafiltration
- Nanofiltration
- Conventional RO
- HERO®
- Electrodeionizaton

HERO

Desalination

Aqua-chem ICD, a division of Aquatech, pioneered MSF and MED technologies in the 1960s. Since then, Aquatech has supplied several thermal desalination systems based on MSF and MED technology with different energy alternatives. Aquatech's expertise and experience also extends to membrane based desalination systems, a unique qualification by which we can evaluate both technologies and offer our customers the most cost-effective option for their specific needs.

Desalination Technologies

- Spray Film™ Multiple Effect Distillation (MED)
- Multi Stage Flash (MSF)
- Vapor Compression (VC)
- Sea Water Reverse Osmosis

Recycle / Reuse

Whether industrial wastewater or produced water from oil fields, Aquatech offers the expertise and technologies to provide an integrated system, with single point responsibility, for treatment of waste streams and make them suitable for recycle / reuse in your plants.

Recycle/Reuse Applications

- Automotive
- Electronics
- Petrochemical
- Petroleum Refining
- Power Generation
- Gray Water
- Cooling Tower Blowdown
- Oilfield Produced Water
- Semiconductor

Zero Liquid Discharge

To comply with stringent regulatory discharge requirements, Aquatech has several installations for the treatment of industrial wastewater leading to a Zero Liquid Discharge system. Aquatech meets these requirements in several different ways depending upon the logistics and economics of the specific project.

Aquatech supplies systems based on either membrane processes, evaporative processes or a hybrid combining the two processes to achieve Zero Liquid Discharge from the plants in a cost-effective manner. The hybrid approach, combining the membrane and evaporative technologies, results in systems having low life-cycle costs compared to other available technologies.

ZLD Technologies

- Vertical Tube Falling Film Evaporators
  - Seeded Slurry (Brine Concentrators)
  - Non-seeded Evaporators
- Forced Circulation Crystallizers
- HERO™ Technology
- Sludge Dewatering
  - Filter Press
  - Centrifuge
  - Drum Dryers

Industrial Concentration

Aqua-chem ICD, a division of Aquatech represents 40 years of experience in providing evaporative systems for the concentration of various industrial products. This experience includes a wide range of technologies to meet your specific applications.

Industrial Concentration Technologies

- Vertical Falling Film Evaporator
- Horizontal Spray Film™ Evaporator
- Forced Circulation Crystallizer
- Submerged Tube Evaporator
- Rising Film Evaporator
- Multiple Effect Evaporator

aqua-chem ICD
Industrial Concentration & Desalination

Laboratory & Pilot Studies

Aquatech operates a well-equipped laboratory and provides pilot test capabilities for bench scale or on-site testing of various technologies in order to establish design and performance parameters for specific applications. Our laboratory testing includes analytical, boil-up tests, and on-site tests using the actual configuration of a commercial scale system.

On-site testing can be performed on any of the following technologies either for stand alone units or a combination:

Pilot Plants

- Vertical Tube Falling Film Evaporator
- Forced Circulation Crystallizer
- Spray Film™ Evaporator
- HERO™ Technology

WATER MANAGEMENT SERVICES

Aquatech is more than just a systems supplier. Our Water Management Services Group (WMS) is focused on supporting plant personnel and end user organizations to get the most out of their water treatment system — whether it is a system originally supplied by Aquatech or another company.

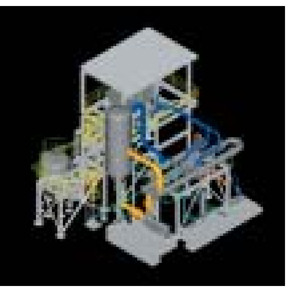
WMS has a large portfolio of water treatment related services which include:

- **Spare Parts Supply**
- **Operation & Maintenance Contracts**
- **Technical Audits**
- **Leased Water Treatment Systems**
- **Technical Training**
- **Annual, Quarterly, and Monthly Maintenance Contracts**
- **Remote Monitoring**
- **Build Own Operate Contracts (BOO)**

PERFORMANCE PRODUCTS

In addition to custom engineered water treatment solutions, Aquatech has a line of standard products already engineered to fit your smaller water treatment requirements.

Many times our clients have water treatment needs that don't require a custom engineered solution, but still demand a quality product. Aquatech Performance Products were designed for that customer.



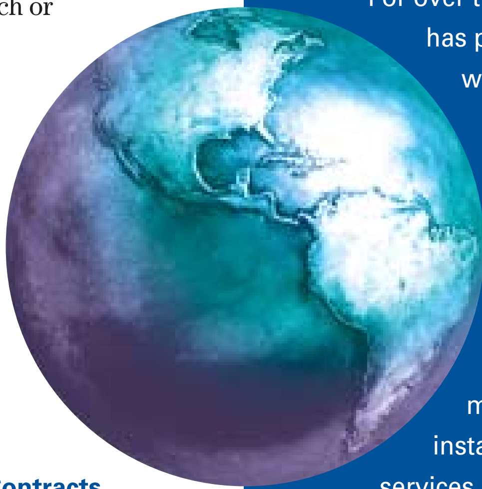
Recomax™
A high efficiency membrane system suitable for wastewater recycle / reuse applications flow range of 50 to 150 gpm.

Crystal™
A forced circulation crystallizer for flow rates up to 10 gpm to provide a cost effective Zero Liquid Discharge (ZLD) solution.

WaterTrak™
Demineralization (DI), reverse osmosis (RO), and electrodeionization (EDI) systems based on a functional design derived from 20+ years of experience in the industry. Watertrak is the most cost-effective and fast solution for pure water treatment in the industry today.
Flow ranges from 50 gpm to 300 gpm.

For more information please visit our website at www.aquatech.com

From Innovation Flows Leadership



For over two decades, Aquatech has provided industry worldwide with proven water and wastewater treatment system installations. By leveraging design and engineering, modular field-proven products, project management, turnkey installation, and industrial services, we develop total water solutions that work together seamlessly.

Our wide range of products address everything from ultrapure water requirements for microelectronics and pharmaceutical industries, to workhorse installations for steam generation in power and chemical processing plants, to the recycle and reuse of sewage or cooling tower blowdown. Innovative, integrated solutions translate into superior products and unmatched value for our customers.

Aquatech

CORPORATE OFFICE

Aquatech International Corporation
One Four Coins Drive
Canonsburg, PA 15317 USA
Telephone: 724-746-5300
Fax: 724-746-5359
E-mail: aic@aquatech.com

U.S. LOCATIONS

Texas
3535 Briar Park Drive
Suite #207
Houston, TX 77042 USA
Telephone: 832-251-9339
Fax: 832-251-9341
E-mail: mittald@aquatech.com
Contact: Devesh Mittal
Senior Sales Manager

Florida
238 E. Davis Boulevard
Suite #203
Tampa, FL 33606 USA
Telephone: 813-251-4991
Fax: 813-251-3320
E-mail: randallp@aquatech.com
Contact: Patrick Randall
Regional Sales Manager

Aqua-chem ICD
1120 James Drive
Suite B-105
Hartland, WI 53029 USA
Telephone: 262-369-9595
Fax: 262-369-9494

WORLDWIDE LOCATIONS

Aquatech Systems (Asia) Pvt. Ltd.
Plot No. 3 Survey No. 250/5
Sankalp Park, (End of D.P. Road)
Aundh, Pune 411 007 India
Telephone: 91-20-2729-9105
Fax: 91-20-2729-8805
E-mail: asa@aquatech.com
Contact: Sachin Kukade
General Manager-Sales

China
Aquatech (Guangzhou) Water Treatment Company Limited
Room H, 15 Floor, Huihua Building
80 XianLie Zhong Road; Guanzhou
People's Republic of China 510 070
Telephone: 86-20-376-16285
Fax: 86-20-376-16787
E-mail: kfwong@aquatechgz.com

Mexico
Ejercito Nacional #57-302
Col. Veronica Anzures
Mexico DF 11300
MEXICO
Telephone: 52-55-5260-6357
Fax: 52-55-5260-1530
E-mail: barriosf@aquatech.com
Contact: Francisco Barrios
Regional Sales Manager

Canada
259 Midpark Way S.E.
Suite 205
Calgary, Alberta T2X 1M2
CANADA
Telephone: 403-256-8700
Fax: 403-256-8745
E-mail: kulkarnim@aquatech.com
Contact: Milind Kulkarni
Regional Sales Manager

www.aquatech.com

PROJECT PROFILE SERIES # 52

ENEL Power, Italy – Fusina Project – ZLD Plant for FGD Wastewater Treatment

The Facility

The Fusina Power Plant is equipped with four coal-fired units with a total capacity of 975 MW capacity (1x165 MW + 1x170 MW + 2x320 MW). The Environmental Refurbishment (Flue Gas Desulpharization, FGD) project includes a new DeSOx system for common for units # 1 &2; two DeNOx systems, one each for unit # 1 & 2. Units # 3 & 4 are already equipped with DeSOx and DeNOx systems.

For units # 1 & 2, Industrial grade water is used as FGD make-up. Flue gases in the FGD are treated with limestone in the scrubber. The FGD blow down wastewaters are treated in the dealkalizer clarifier with lime treatment.

For units # 3 & 4, the flue gases are treated sequentially by SCR-DeNOx with ammonia as reagent, High efficiency ESP to remove fly ash and wet limestone gypsum forced oxidation DeSOx. Each unit is equipped with DeSOx system with a prescrubber for final dedusting and gas saturation and an absorber. The FGD blow down wastewaters along with units #1 & 2 are treated in the dealkalizer clarifier with lime treatment and being discharged into the surface waters.

The Problem

Wastewaters from FGD treatment plant can no longer be discharged into the sea due to tough Italian and EU environmental regulations. In order to overcome this problem, ENEL decided to install the Zero Liquid Discharge (ZLD) plant so that no industrial wastewater discharges are allowed.

The Solution

To overcome the problem, ENEL selected the Softening –Evaporation – Crystallization (SEC) process to treat the wastewaters and reuse/conserve fresh waters. Aquatech supplied, installed, commissioned the ZLD plant as an EPC contractor with local associates.

The SEC plant comprises of 2X50% Softener Clarifiers (calcium reduction by soda ash dosing), 2x50% Falling film type Brine Concentrators (each equipped vapor compressor), 1x100% Crystallizer (equipped with Thermocompressors) and 2x50% Belt Filter Presses. The plant also includes several chemical dosing systems, storage tanks, pumping systems, electrical works (MCC, cable trays, cabling etc), Controls & Instrumentation.

The Zero Liquid Discharge (ZLD) plant is a fully integrated automated system. The Brine Concentrators operate in seeded slurry mode. Each Brine Concentrator is equipped with internal mist eliminator. The Crystallizer operates in forced circulation method.

The industrial grade soft water and high purity distillate produced in the system will be used in the main power plant.

Aquatech

Aquatech International Corporation
One Four Coins Drive; Canonsburg, PA 15317
T: 724-746-5300 F: 724-746-5359 aic@aquatech.com www.aquatech.com

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Industrial Concentration & Desalination

PROJECT PROFILE SERIES # 52

DESIGN FGD WASTEWATER ANALYSIS

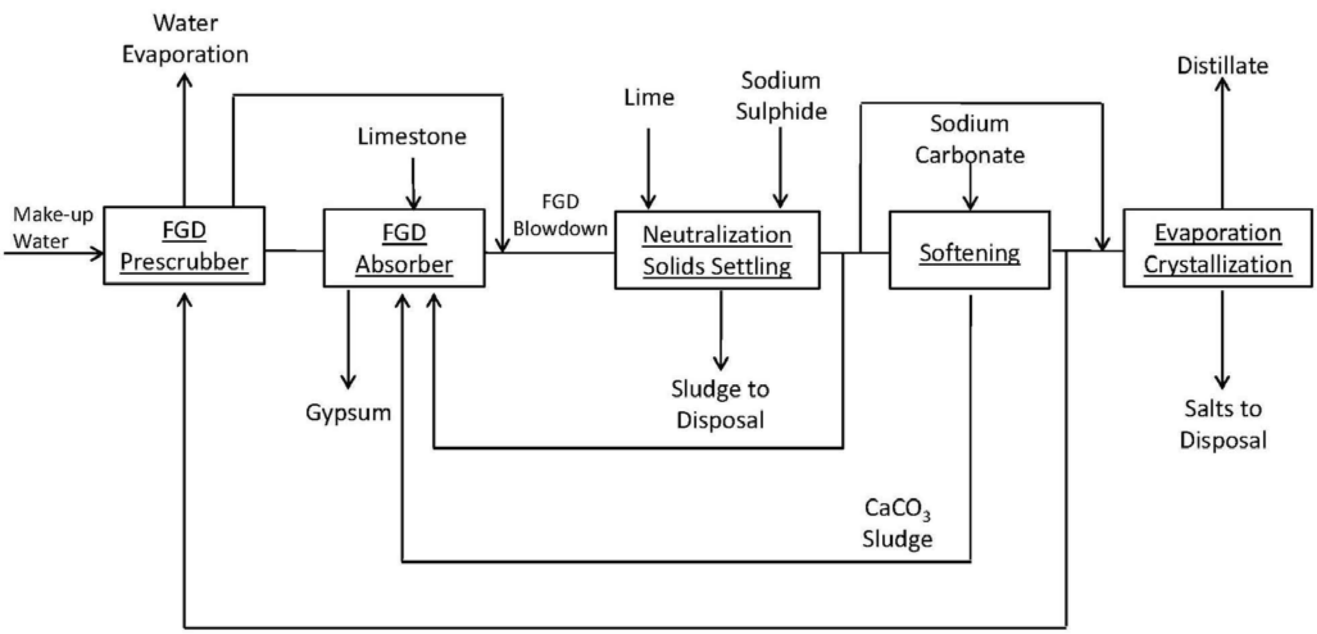
Design Flow .... **70M3/hr (PT Plant)**

Calcium: .... **8400 ppm**
Magnesium: …………..**1700 ppm**
Sodium: .... **Balance**

TSS .... **80 ppm**
pH................................ **9.5 to 10**

Chlorides .... **25000 ppm**
Nitrates .... **300 ppm**
Sulfate…………………**1200 ppm**

PROCESS FLOW DIAGRAM



Aquatech International Corporation
One Four Coins Drive; Canonsburg, PA 15317
T: 724-746-5300 F: 724-746-5359 aic@aquatech.com www.aquatech.com