Conco Services Corporation

Reducing Water and Fuel Consumption Through Optimization of Plant Cooling Systems

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BLASTINGMAR

7.4 Billion People on Earth

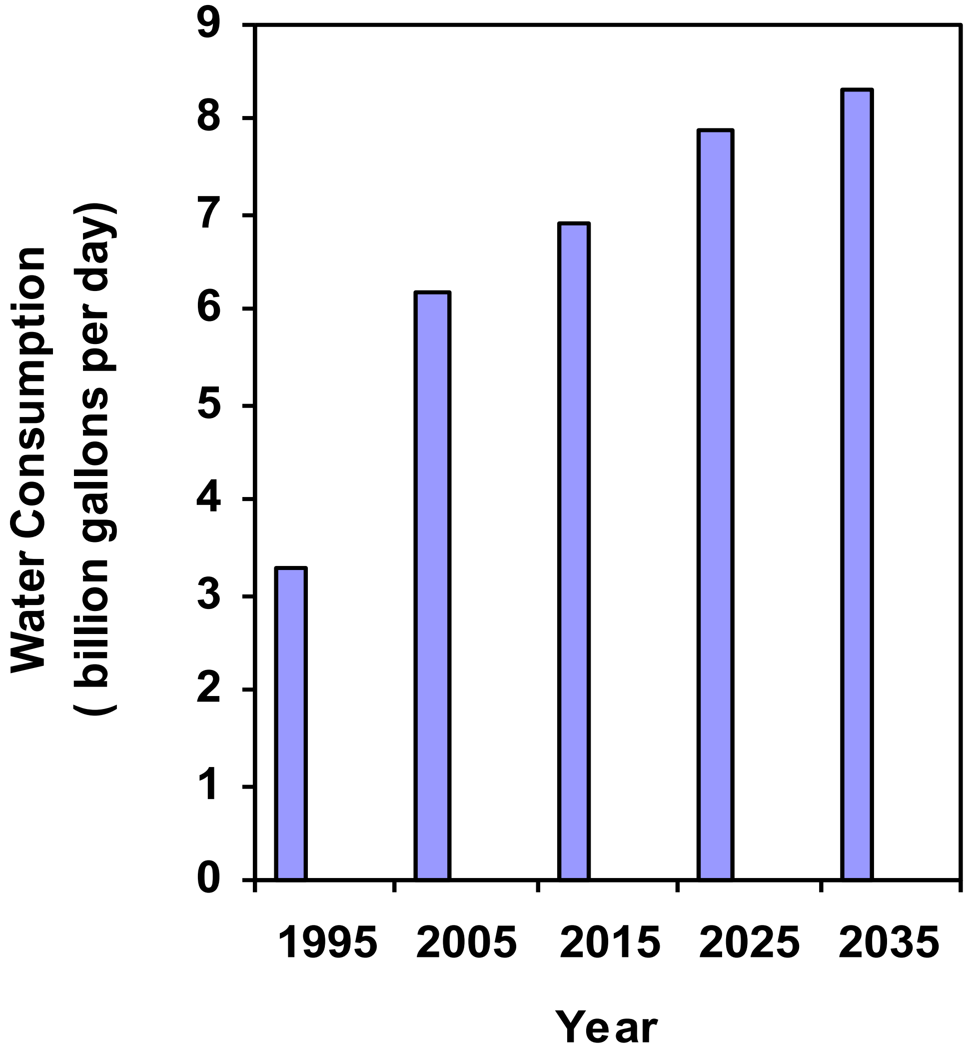
- Half of population already live in urban areas
- 2.6 billion lack basic sanitation
- 1.3 billion lack access to clean water
- 1.4 billon lack access to electricity

Energy-Water Nexus

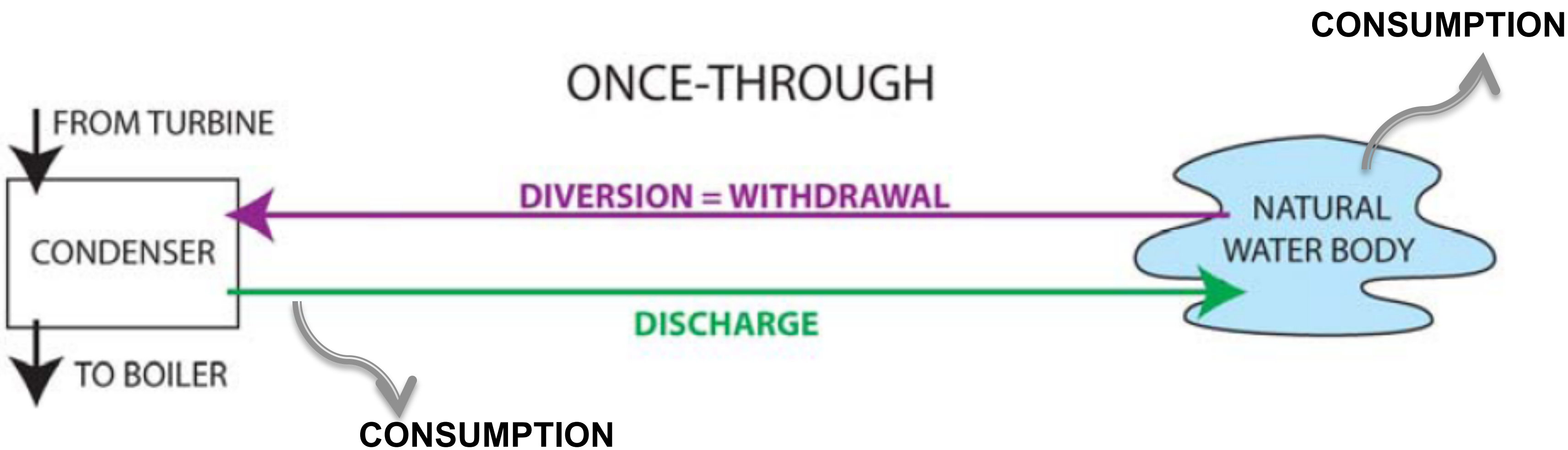
- ASME's initiative via the ASME Energy-Water Interdisciplinary Council
- Modern society is driven by a plethora of industrial, agricultural, and residential activities involving the consumption of energy and water.
- The energy-water nexus covers a broad array of activities and technologies.

Water Demands for Future Electric Power Development

- Water demands could almost triple from 1995 consumption for projected mix of plants and cooling
- Carbon emission requirements will increase water consumption by an additional 1-2 Bgal/day

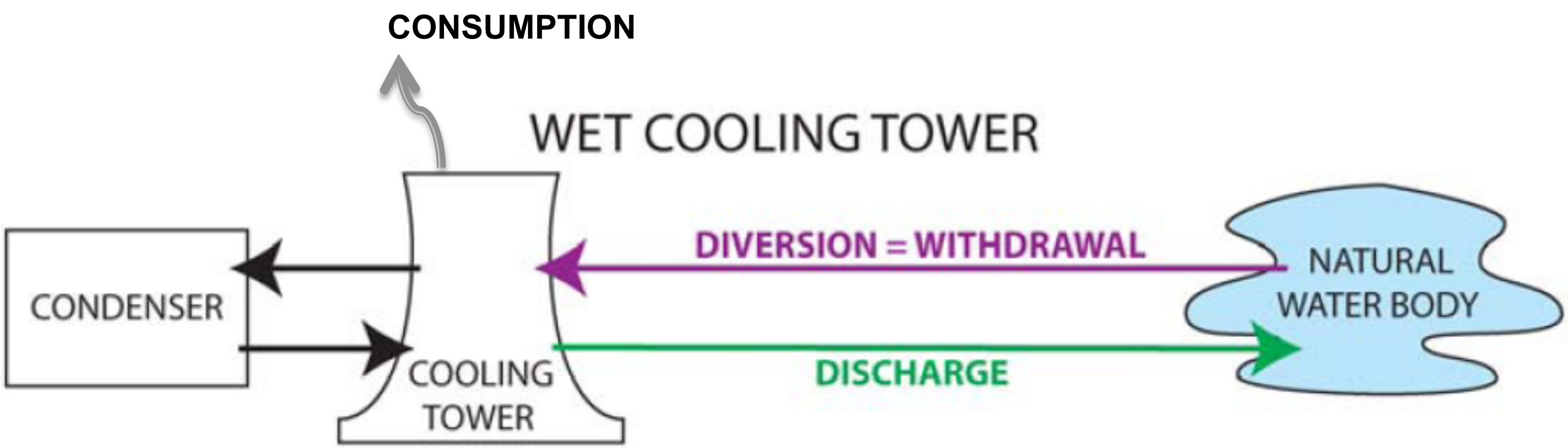


Once-through Cooling



Adapted from *Form EIA-923*: *Power Plant Operations Report Instructions.* U.S. Energy Information Administration, 2011.

Recirculating Cooling



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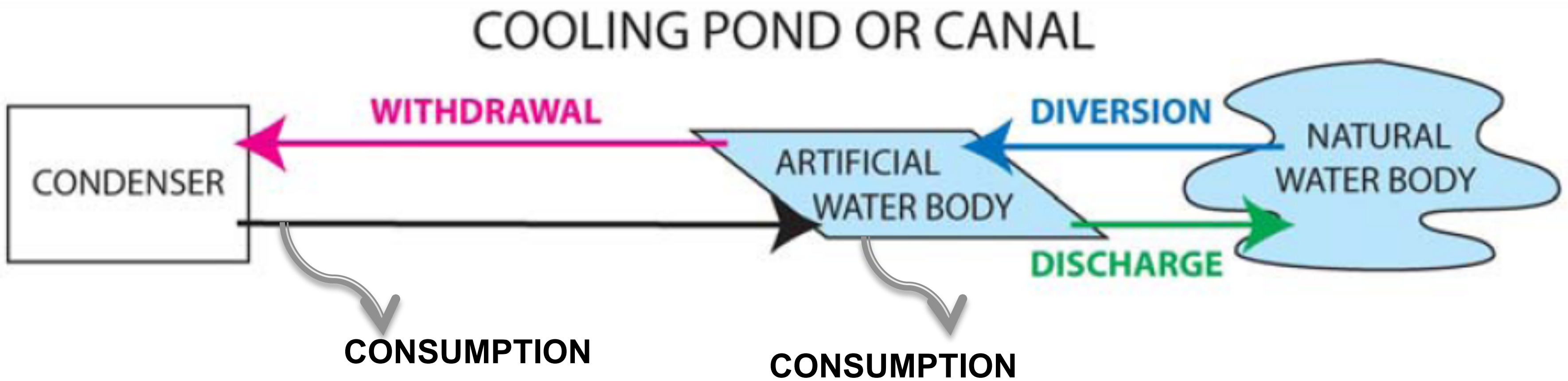
Pond Cooling



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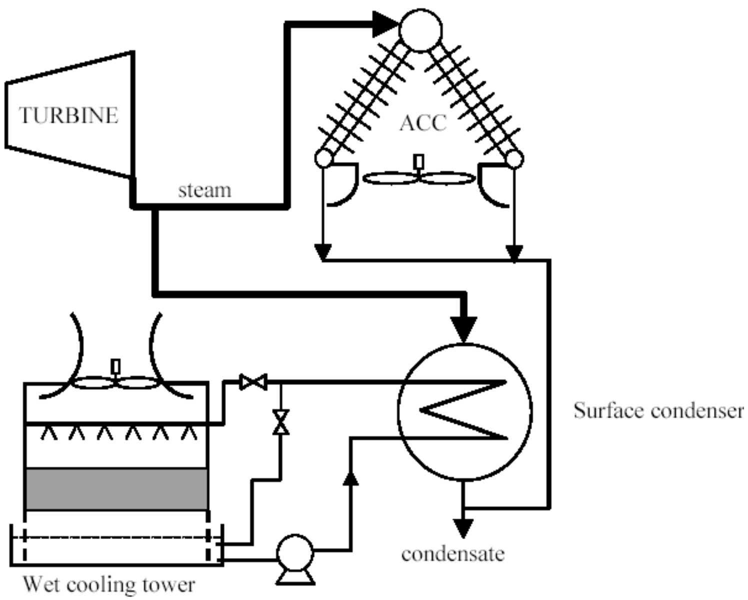
Research Program for Electric Power Sector



Hybrid Wet-Dry Cooling System

- Improve dry and hybrid cooling system performance
- Improve ecological performance of intake structures for hydro and once-through cooling
- Improve materials and cooling approaches compatible with use of degraded water
- Electric grid infrastructure upgrades to improve low water use renewable technology integration

Surface Cleaning an ACC

Conco Services Corp. USA

Effective Utilization or Optimization of Existing Technology

- For Improvements to Condenser Efficiency by:
  - Effectively Cleaning the Condenser
  - Using Tracer Gas Leak Detection for Air and Water In-leakage
  - Performing Eddy Current Testing NDE
- Well Maintained Cooling Systems Optimize Value of the Cooling Water
- Less Fuel is Consumed

Mechanical Cleaning Options

- Most frequently chosen
- Generally applicable and effective
- Fast and easy to use

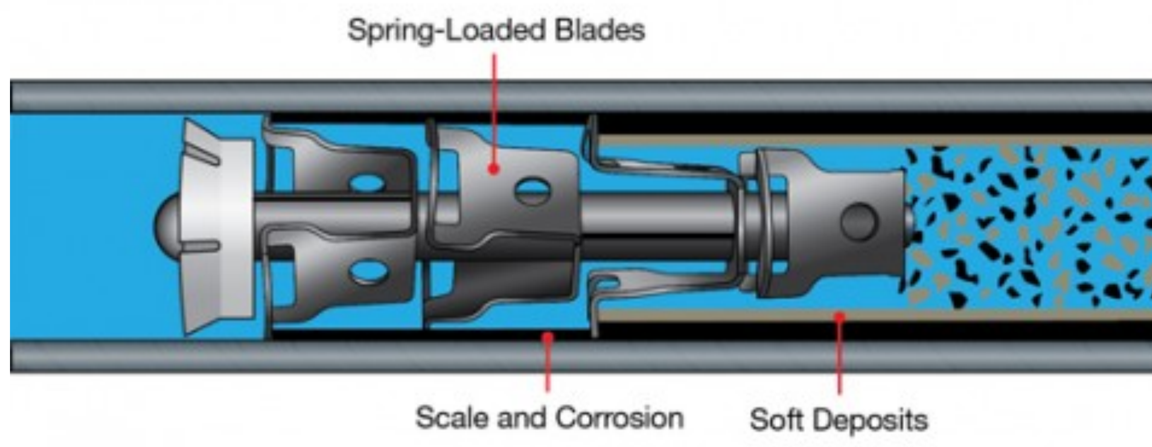
More Importantly:

- Improve heat transfer
- Protection from under-deposit corrosion
- Restore flow

Mechanical Tube Cleaning

- Minimizes unit downtime – normal crew can clean 5000 tubes during a 10-hour shift
- Cleaners are effective on all types of deposits and will remove:
  - Fouling deposits
  - Corrosion products
  - Physical obstructions
  - Tube surface roughness

Spring-Loaded Cleaner in Action



Conco Services Corp. USA

Innovations in Tube Cleaners

Hex Cleaner

Stainless Steel Tube Cleaning Brush

Cal-Buster™

Tube Cleaning

- Select the most effective tube cleaner.
- Insert the tube cleaners into each tube.
- Utilizing the water gun and pump system the cleaners are "shot" through the tubes.

Potential Savings from Improving Back Pressure

Pressure Deviation (inches Hg) (Excess Back Pressure)	**Turbine Rating (MWatts)**			
	100	**400**	**600**	**1,000**
0.1	$31,250	$125,000	$187,500	$312,500
0.2	62,500	250,000	375,000	625,000
0.3	91,750	375,000	562,500	937,500
0.4	125,000	500,000	750,000	1,250,000
0.5	156,250	625,000	937,500	1,562,500

***Source*: "Operation and Maintenance of Steam Surface Condensers", Fossil Plant News, EPRI**

Typical Results
Pre and Post Cleaning

		Before	After	Chg.
A Back Pressure	Inches Hg.	3.6	2.8	-0.8
B Back Pressure	Inches Hg.	4.3	2.9	-1.4
Circ Water Velocity	Ft/sec	5.7	6.5	+0.8
Net Generation	MW	659.4	686.5	+27.1

Additional Benefits

- Economic Benefit
  - Immediate Return on Investment
  - Reduced Costs
- Recovery of lost megawatts or increased generation capacity
- Fuel savings
- Reduction in CO_2 emissions
- Extended useful life of the condenser

Quick Calculations

Heat Rate

- Assume .3 hg condenser backpressure is equivalent to 10% improvement in condenser performance
- Each 10% improvement in the condenser correlates to 1% improvement in HR (10,000 btu/kWh) or MW output

Ex: .6 hg = 20% CF = 2% HR = 2 MW

MW loss

- 8760 hrs./yr.
- Capacity Factor
- Price per MWh
- MW

Ex: 8760 x .70 x $60.00 x 2 MW = US $ 735,840.00

Ex: 8760 x .70 x $60.00 x 3 MW = US $1,103,760.00

Tracer Gas Leak Detection

Leakage of air or water into the condenser will adversely affect plant efficiency, reliability and availability

- Increased plant heat rate
- Increased risk to turbine components
- High levels of dissolved O_2 in feedwater means increased deterioration of boiler and feed systems

When Plants Need to Test

Proactive Testing

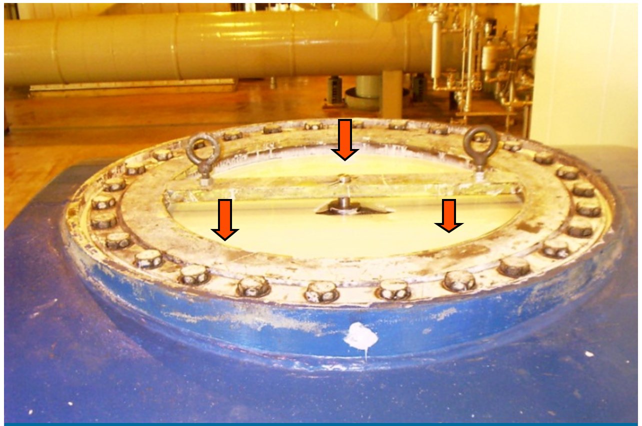
- Routine inspection to understand where potential failures will occur
- Before an outage so components in need of repair are scheduled for repair
- After an outage to insure all repairs were made successfully

Reactive Testing

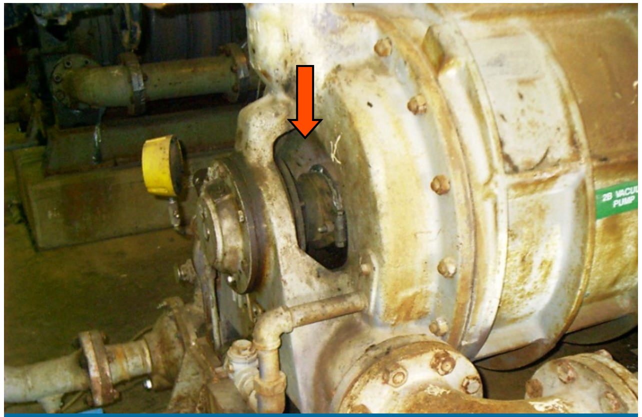
- Emergency inspections as a result of catastrophic failure or because inleakage has exceeded the air removal system capability

Sources of Air Inleakage

- Inleakage to shell
- Rupture discs
- Shaft seals
- Test probe penetrations
- Man ways
- Vacuum pumps
- Flanges
- Bolt holes



Rupture Disc



Vacuum Pump Shaft Seal

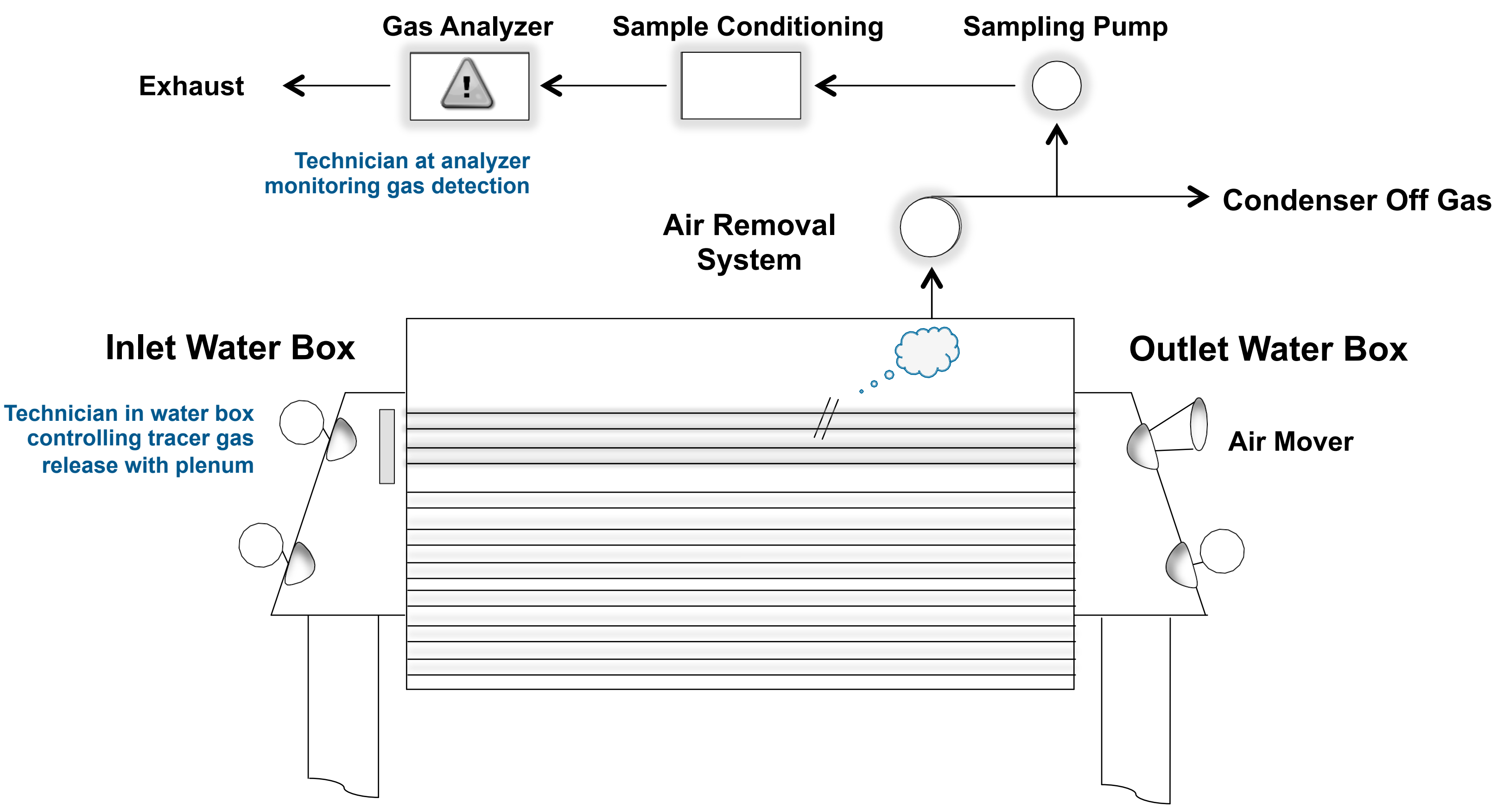
Sources of Water Inleakage

- Water box flanges
- Faulty tube plugs
- Leaking hotwell components
- Through-wall penetrations
- Tube to tubesheet joints

Tubesheet joints

Through-wall penetrations

Tube Inspection Set Up



Air In-Leakage

- Air and water inleakage continues to cost generators hundreds of thousands to millions of dollars annually
- Condenser tube leaks cause more than 6,000 forced outages annually and rank as one of the highest concerns among plant chemists
- In addition to reactive leak detection, a proactive regimen of testing can keep total air inleakage in check
- ROI for leak detection maintenance dollars spent are usually in the 1000% + range, so don't wait!

Typical Weights and Heating Values for Three Major Fuels

Fuel	C lb/lb fuel	HV BTU/lb	lbs. CO_2 / MBTU loss	lbs. Carbon/ MBTU loss
Bituminous Coal	0.86	13930	238.1	64.987
Fuel Oil	0.863	18558	179.4	48.950
Natural Gas	0.749	25128	115.0	31.376

Impact on Emissions

- 1lb. Carbon produces 3.6644 lb. of CO_2
- The table equates equivalent carbon emissions per MBtu loss

If : the fouling loss is 34.968 MBtu
and the fuel is bituminous coal

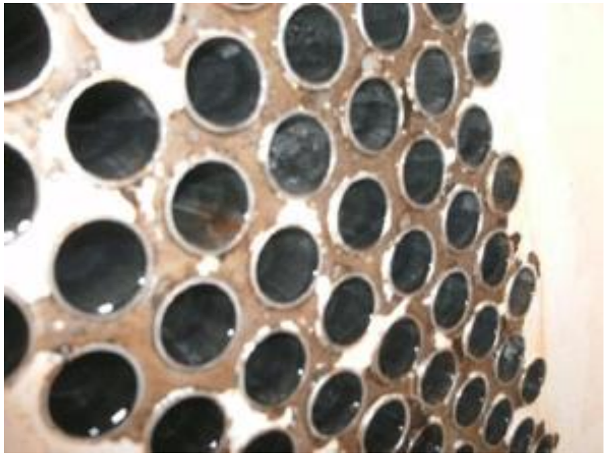
Then :

$$\text{Carbon emissions} = \frac{34.968 \times 64.987 \times 8000}{2}$$

$$= 9.09 \text{ million pounds of carbon per year}$$

Asserraderos Arauco, Vinales CHILE

Cleaning improves performance



"The cleaning of the tubes using CONCO C4S cleaners was excellent, projecting a new cleaning at the next general maintenance of the plant". (Andres Gatica, Nexxo)

Ethanol Production Plant, COLOMBIA

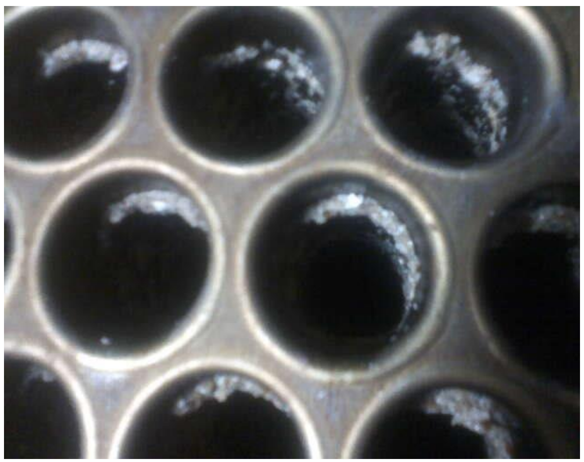
Production rises considerably after cleaning

	Vacuum pressure before cleaning	Vacuum pressure after cleaning
Heat Exchanger A	280 mmHg	496 mmHg
Heat Exchanger B	258 mmHg	711 mmHg

"Due to these new vacuum pressure numbers, the plant was able to obtain a significant improvement on the performance and efficiency of the two heat exchangers, normalizing the factory generation process". (Jhon Batista, Blastingmar)

EDF Norte Fluminense, BRAZIL

1 Ton of dirt removal increases productivity and condenser efficiency



*"Switching from Hydro blasting to the CONCO technology, provided effective cleaning by removing sand and the entire silica deposits from the tube walls". (*Nelson Cansanção Neto, Expander)

Genelba-Petrobras, ARGENTINA

Mitee Mouse II, Cal-Busters and C4S Cleaners demonstrated exceptional performance despite extremely hard and compact deposits

"The DSL group, with the support of Conco, unblocked and cleaned 30,000 tubes in 7 days, recovering the heat exchanger". (Martin Formoso, DSL Group)

Conclusion

- Optimizing the value of the cooling water will reduce water consumption, incorporating the application of *state-of-the-art* technologies for condenser cleaning and air in-leakage detection major improvements can be achieved.
- This presentation demonstrates the correlation between improved condenser performance, reduced fuel consumption and a reduction in CO_2 emissions.
- Literally, tons of emissions and fuel have been avoided due to the implementation of these sound practices.
- The technology is available for deployment in South America.