

## Heat power station steam condenser protection from biofouling

Different inorganic deposits and biofouling formation in the heat-exchange equipment in steam condensers reduces heat-transfer efficiency, which, besides other consequences, leads to excess fuel consumption.



Placard in heat power station turbine workshop.

The text is: 0,1% vacuum loss cause excess 1800 tons of standard coal fuel

The volumes of water used for cooling of heat stations and power stations are huge. Chemical agent usage for prevention of scale and for disinfection is quite complicated here, especially in open (not closed-loop) systems.

The main restrictive factor is using a large quantity of chemical agents. Environmental safety requirements are also a factor, because blow-down water from the water circulation system is eventually discharged to natural water basins and for this reason must comply with maximum permissible concentration requirements.

That is why in most cases cooling water is supplied to heat-exchange equipment almost without any treatment, and when internal surfaces of heat-exchange equipment reach some critical contamination level, equipment is stopped for chemical cleaning or for dismantling and mechanical cleaning.

Cleaning of heat-exchange surfaces from deposits requires significant material expensive and is performed, as a rule, on idle equipment. Moreover, heat-exchange surface cleaning leads to mechanical damaging of equipment and, in fact, it eliminates the consequence (i.e. the deposits), while the cause of deposit formation remains, and sometimes, such cleaning may even aggravate the case.

In many instances the situation with biofouling growth in cooling systems can be improved by the AquaKlear water conditioner.

AquaKlear causes flocculation without chemicals, it forms “flock” (larger particles) from colloidal and suspended particles, as well as from micro particles of existing deposits from pipe surfaces, and in addition kills some types of bacteria. The surface of the flocks created adsorbs spores, preventing bacteria reproduction. Flocks adsorb organic materials in water as well, which deprives microorganisms food source.

AquaKlear is safe for the environment. It differs with very high functional efficiency, simplicity of installation, high reliability and minimal operational costs.

**Let us consider a case study how AquaKlear is used for heat power station steam condenser protection from biofouling.**

**Date:** November 2010 — July 2011

**Place:** Barnaul, Russia – population 612,000. The city is situated relatively close to the border with Kazakhstan, Mongolia and China.

**Object:** heat power station. The station produces electricity and heat energy, which is used for central heating. The electrical power is 430 megawatt (0.43GW), and heat power - 1460 gigacalories per hour. To put this into context Russia's total generating capacity is about 200 GW.



foto: [www.amic.ru](http://www.amic.ru)

**Application:** Steam condenser protection from bio-fouling.

**Problem:** biofouling, silt and mud deposits, (source of the water is river), inorganic deposits (scale) forming on the internal steam condenser pipes surfaces.

**Units:** AquaKlear Custom P-40" x 2 pcs., main pipes are 1000 mm each.



AquaKlear Custom P-40” is installed on a pipeline.

### **Results:**

During the winter time operation the river water has higher salinity, and level of organic matters and biofouling is notably lower. During scheduled shutdown of the power-generating unit at the end of winter, in April, condensers were opened for checking. Deposits were present in tubes of both condensers.

In the condenser with AquaKlear deposits were soft, by touch they resemble the finest powder (this is a character feature of Hydroflow and AquaKlear systems operation). Some tubes contained non-organic buildup, which could be removed with a jet of the water.

Specific powder-like deposits were also found on the rear part of the condenser. This allows us to draw the conclusion that the AquaKlear signal sufficiently passed through all the length of condenser pipes.

When power-generating unit was stopped in summer time, in July 2011, condensers were opened for checking.

**The following was found in the condenser with the AquaKlear:**

- The inlet chamber of the tube bundle partially contained foreign matters (wood chips, plastic parts);
- The internal surfaces of tubes have silt deposits. Characteristics of deposits – soft, can be washed out with the water. On most of the tubes there can be seen a characteristic metal glitter (brass), which indicates cleanness of the surface;
- Properties of deposits in the outlet chamber are similar to that of the inlet chamber, and the brass glitter can also be seen here;
- A characteristic smell of organic decomposition is absent.

**In another power-generating unit condenser the following was found:**

- Inlet chambers of the tube bundle partially contained foreign matters (wood chips, plastic parts).
- Internal surfaces of tubes have deposits. Characteristics of deposits – supposedly, it is river mud.
- The tube bundle have tubes with 100% clogging.
- The number of tubes with 100% clogging is about 10-15% of their total quantity;
- Condenser chambers have strong smell, characteristic for organic materials decomposition.

**Microbiological analysis**

In cooperation with specialists of the Central Analytical Laboratory Vodokanal there was performed probe sampling of source water on the outlet of the pumping station and on the outlet of both condensers. Further, these samples underwent a microbiological analysis for four tests: thermotolerant coliform bacteria, total bacterial count, coliphages, spores of sulfite-reducing clostridia.

Data were assembled in a table.

№	Index	Unit	Research result			
			water from shore pumps 1	after AquaKlear	water from shore pumps 2	after another condenser
1	Thermotolerant coliform bacteria	CFU in 100ml	234	802	126	2621
2	Total coliform bacteria	CFU in 100ml	234	802	126	2675
3	Total bacterial count	CFU in 1ml	220	1200	130	545
4	Coliphages	PFU in 100ml	3	3	not found	6
5	Spores of sulfite-reducing clostridia	CFU in 20ml	18	60	17	∞ many, cannot be calculated

## Chemical analysis

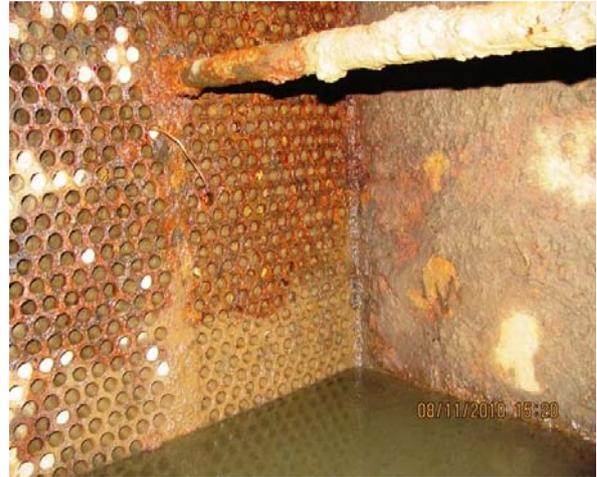
At the moment condenser with the AquaKlear was opened, samples of deposits from the external surface of the pipe from depths from 100mm to 300mm from the expander edge were taken.

Analysis of the chemical composition of these deposits gave the following results:

- loss on ignition	6,2...10,7%
- silicate + impurities	83,5...89%
- iron compounds	5,4...9,1%

## Photos

**Condenser interior before AquaKlear installation, November 2010.**



**Condenser with AquaKlear, July 2011.**



Inlet chamber, bottom



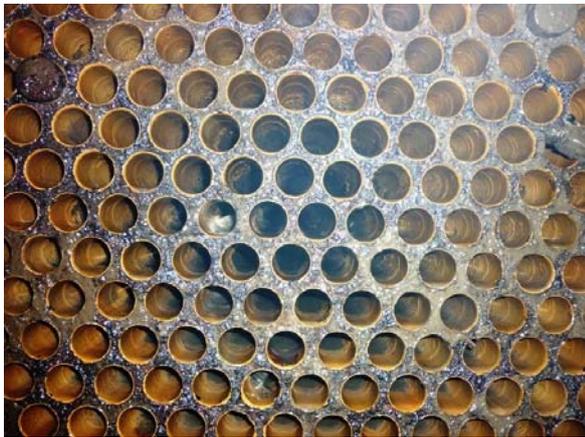
Inlet chamber, bottom



Outlet chamber, top



Outlet chamber, top

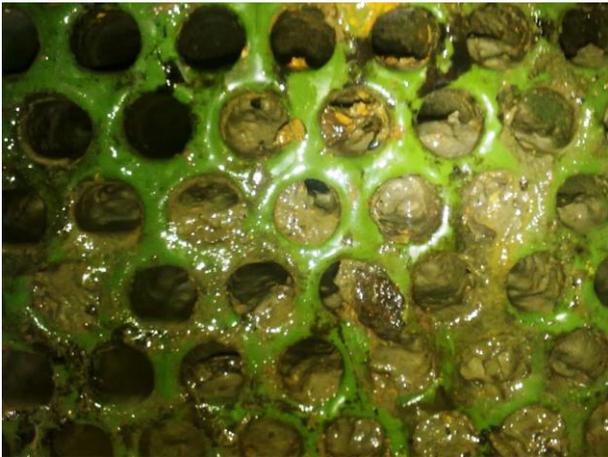


Outlet chamber, top

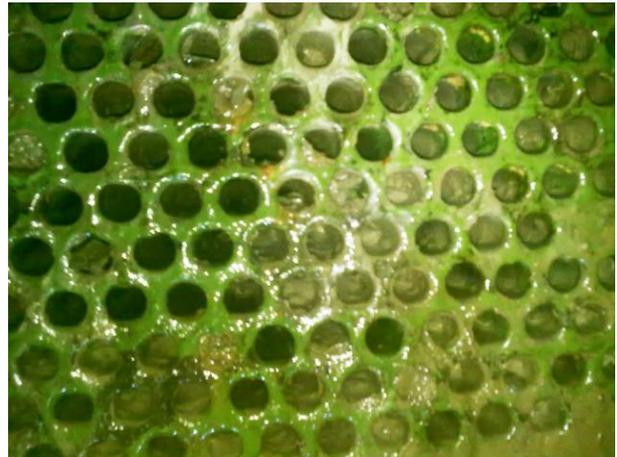


Outlet chamber, top

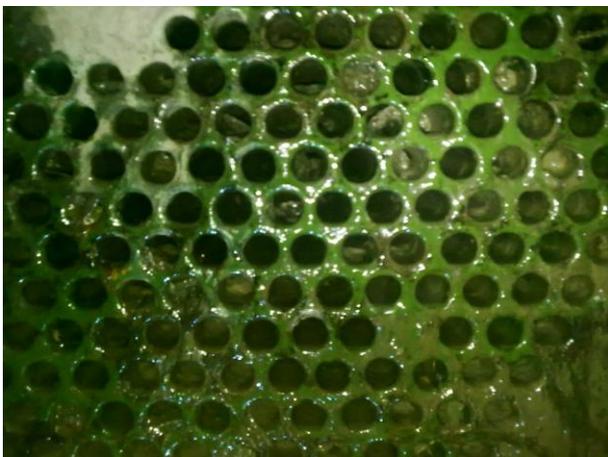
**Condenser of another power-generating unit (without AquaKlear), July 2011.**



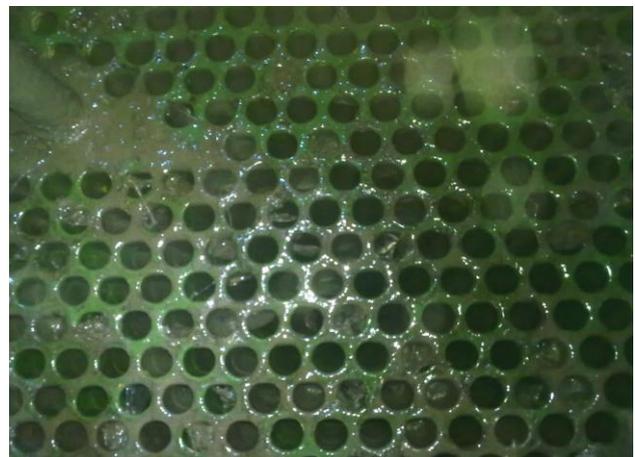
Inlet chamber



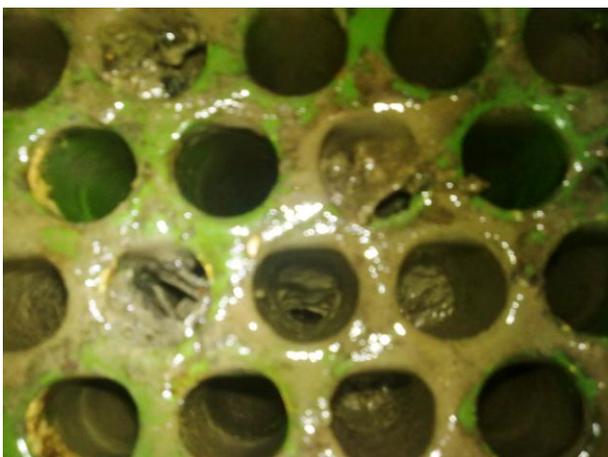
Inlet chamber



Inlet chamber



Outlet chamber



Outlet chamber



Inlet chamber

## Summary

According to findings of the study, specialists of the heat-mechanic equipment checkout and repairing company made the following conclusions:

1. The result of the temperature force monitoring indicates positive dynamics due to cleaning of the condenser heat-exchange surfaces by the AquaKlear system;
2. According to results of the visual examination, there was found visible reduction of biofouling and absence of tubes with 100% clogging in compare with condenser without AquaKlear;
3. Based on microbiological water analysis, it is possible to make conclusion that AquaKlear system suppresses biofouling of steam condenser cooling surfaces in respect of:
  - thermotolerant coliform bacteria > 3,3 times;
  - total amount of coliform bacteria > 3,3 times;
  - total amount of coliphages > 2 times;
  - sulfite-reducing clostridia > 90 times.

Therefore, AquaKlear water conditioner strongly reduce buildup of deposits, silt and biofilm in heat-exchangers.