Part 2

WATER PROTECTION FROM DISCHARGES

2.1. Formation and regulation of waste water discharges from TPPs

2.1.1. Waste water sources and regulation of discharges of power plant waste water into water basin

Shishchenko V.V., VNIPIenergoprom

Power plants of Russia are one of the basic natural water consumers and sources of waster water with different level of contamination. According to "UES of Russia" their share in the total industrial water consumption is about 70%, the main part of it (about 90 %) is discharged into surface water basins as waste water, including 4% of contaminated waste water [1]. Thus efficient water management at such power enterprises is a burning issue.

At thermal power plants the basic part of water is used for steam condensation and equipment cooling, for treatment of boiler feed and heating system make-up water, in slag and ash removal systems. Discharges of waster water from the above mentioned technological cycles together with rain and melted snow water are allowed for discharge under the condition that concentration of the controlled ingredients is within the regulations [2]. Dischargers from slag and ash removal systems are allowed only for the existing power plants. Weight of pollutants in cooling system blow-off water must be equal to that in raw water taken for cooling under the condition of using the same water source. When waste water is discharged into another water source maximum discharge limits of pollutants are established providing water quality standards in the controlled point.

In the case when waste water from different technological systems is mixed and discharged through the same water outlet maximum discharge limit is established for the total (united) flow with consideration of all ingredients. Obligatory list of regulated and monitored thermal power plant waste water ingredients is presented in table 2.1.

Table 2.1. **Obligatory list of regulated and monitored thermal power plant waster water ingredients**

Waster water quality indicators	Discharge source		
	Hydro ash removal	Water treatment	Circulating cooling water system with cooling towers
Suspended substances	+	+	+
pH	+	+	+
Biologic oxygen consumption	+	—	—
Salt content	+	+	+
Chloride Cl^-	+	±*	±*
Sulphate SO_4^{-2}	+	±*	±*
Oil	+	+	+
Calcium Ca^{+2}	+	—	—
Iron Fe^{+3}	+	±*	—
Aluminium Al^{+3}	+	±*	—
Cuprum Cu^{+2}	—	—	+

* Monitored depending on a reagent applied

Contaminants in discharges of direct-flow and circulating cooling water systems with pond-coolers are monitored according to the full list of waste water ingredients, agreed with the territorial bodies of the Ministry of natural recourses of Russia. List of waste water quality ingredients for hydro ash removal systems is agreed additionally in dependence with brand of coal burnt, including concentration of manganese, vanadium, arsenic, selenium, fluorine and chrome. Other kinds of technological waste water (oiled and fuel oiled water, water used for chemical washing of equipment, washing of regenerative and convective heating surfaces of boilers, etc) are to be re-used inside a power plant or sent under the arrangement for recycling to other enterprises [2].

Regulations for the general properties of the waste water accepted into municipal sewerage systems, are uniform for waste water of all categories of subscribers established to protect networks and constructions of sewerage systems [3]: waste water temperature — no more than 40 °C; pH — within the range from 6,5 to 8,5; diluting rate when coloring in 10 sm water column disappears, — no more 1:11; COC/BOC_5 (chemical oxygen consumption/biological oxygen consumption)— up to 2,5; COC/BOC_{total} — up to 1,5. General mineralization of discharges to household and cultural and community type of water sources is up to 1000 mg/l. General mineralization when discharging to water object of fishery type is regulated according to toxicity capability (Toxicity capability - ability of organisms to inhabit in water containing various quantity of toxic substances. GOST 27065-86: Quality of waters. Terms and definitions) of a fishery type water object and usually is not higher that 1000 mg/l. Maximum concentration limit of contaminants also depends on a water reservoir purpose where such waste water is finally discharged [3].

However in the conditions of traditional thermal power plant water management systems even observing the specified above restrictions to waste water discharges total quantity of substances in waste water is considerably higher than that in raw water taken. First of all it is caused by wide application of ion-exchange technologies for demineralization of boiler make-up water and softening of additional water for heating systems at domestic thermal power plants.

Common type of chemical demineralization in Russia is a two and three stage water treatment plant, consisting of a considerable number of parallel flow ion exchangers with fittings, measuring instruments and front pipelines. Along with single stage plants two stage Na-cationic exchange and H-Na ion-exchange treatment are often used for water softening, requiring considerable investments, operation and repair staff, and also complicates automation of water-treatment plants.

For loading of power plant water treatment ion-exchangers considerable amount of domestic and imported ion exchange resins is purchased. About 150 thousand tons of sulfuric acid, 80 thousand tons of caustic soda and about 240 thousand tons of salt are consumed at thermal power plants annually for regeneration of thermal power plant ion exchange resins of water demineralization and softening. Since consumption of reagents for regeneration of ion exchange resins is in practice 2-4 times higher than its stoichiometric amount, most of such reagents are discharged into surface water basins as liquid neutral wastes [4].

The tendency which has outlined recently of parallel-current technologies substitution by counter-current vividly reduces unit consumption of reagents for regeneration of ion resins with corresponding reduction of salts in waste water. However even at most optimistic forecasts the consumption of reagents for regeneration of ion resins will remain at a high level. Hence, problem of discharge of additional quantity of mineral admixtures with power plant waste water and task of maintenance of maximum concentration limit in them remains. Currently this problem is solved by dilution of water treatment waste water by blow-off water of circulating cooling water systems.

However the tendency which has outlined recently of use of blow-off water of circulating cooling water systems as initial for water treatment (Saransk thermal power plant-2, the Kazan thermal power plant-3, the Tyumen thermal power plant-2, etc.) deprives thermal power plants of such possibility and also compels to search ways of designing of low-waste systems of water treatment.

In such conditions for thermal power plants, where for whatever reasons problems with maintenance of maximum discharges limit of sulfates and chlorides and also of total quantity of contaminants exists, it is necessary to implement technologies of water treatment demanding minimum consumption of reagents and providing separation of part of initial water admixtures in a kind, suitable for the subsequent recycling or safe warehousing.

References to § 2.1

1. **Bersenev A.P., Mikushevich V.M.** Prevention of extreme pollution of water object when design and operation of power plants//New in Russian electric power engineering: Scientific-technical electronic magazine of JSC “UES of Russia”. 1998. № 1 (43). C. 2—13.
2. **Management directive -RD 153-34.0-02.405.99.** Methodic recommendations for regulation of contaminant discharges with power plant waste water. M.: JSC “UES of Russia”, 2000.
3. **Methodic** recommendations for estimation of quantity and quality of waste water and contaminants discharged into municipal sewerage systems of settlements MDK 3-01.2001. M.: Gosstroy Rossii, 2002.
4. **Yurchevsky Y.B.** Contemporary domestic water treatment equipment for demineralization and softening of water at thermal power plants// Thermal Engineering. 2002. № 3. pp. 62—67.