

## Activation of Raw Water Pre-Treatment Facility in PLTU Ombilin

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### Abstrak

Pada sebuah Pembangkit Listrik Tenaga Uap (PLTU), seperti di PLTU Ombilin, Sumatera Barat, air digunakan terutama untuk air umpan boiler, untuk pendingin, pemadam kebakaran, service water, dan air minum. PLTU Ombilin menggunakan Sungai Ombilin sebagai sumber air baku untuk memenuhi semua kebutuhannya akan air. Sebelum dapat digunakan untuk memenuhi semua keperluan tersebut, air baku harus diolah terlebih dahulu melalui berbagai tahapan untuk menghilangkan berbagai pengotor yang secara alami terkandung di dalamnya. Penelitian ini bertujuan untuk merancang unit pengolahan awal air baku untuk utilitas di PLTU Ombilin dan membandingkannya dengan unit pengolahan yang sudah ada dan beroperasi. Untuk keperluan perancangan digunakan data laju alir air yang diolah yang diperoleh dari lapangan yaitu sebesar 1.160 m<sup>3</sup>/jam. Perancangan ditujukan untuk menyisihkan TSS, patogen, dan kekeruhan yaitu dengan menggunakan prinsip-prinsip koagulasi, flokulasi, sedimentasi, disinfeksi, dan membran ultrafiltrasi. Hasil perancangan ini berupa rangkaian proses yang tersusun dari static mixer, flokulator, clarifier, dan membran ultrafiltrasi, serta dengan menggunakan senyawa kimia meliputi alum, kapur, NaOCl, dan polielektrolit. Static mixer yang digunakan memiliki diameter pipa sebesar 16 in. Flokulator dirancang berupa saluran berpenampang (2x2) m<sup>2</sup> dengan panjang 100 m. Clarifier berupa unit aliran horizontal, dengan permukaan (40 x 20) m<sup>2</sup> dan kedalaman 5,8 m. Clarifier ini memiliki laju beban permukaan 35 m<sup>3</sup>/m<sup>2</sup>.d, laju beban weir 250 m<sup>3</sup>/m.d dengan panjang weir 111,36 m. Membran ultrafiltrasi hanya mengolah 80% air umpan, dengan fluks 50 lmh, dan luas permukaan yang dibutuhkan 13.290 m<sup>2</sup>. Dari perbandingan hasil perancangan dan unit pengolahan yang sudah ada, didapatkan rekomendasi bagi unit pengolahan yang ada untuk tidak menggunakan screen, memodifikasi flokulator dan clarifier, serta mengganti saringan pasir dengan membran ultrafiltrasi.

**Kata kunci:** Pengolahan air, filtrasi, sedimentasi, koagulasi dan flokulasi umpan boiler.

### Abstract

In a power supply (PLTU) located in West Sumatera Barat, water is massively utilized for boiler feed, chiller fire fighters, service water, and drinking water. This need is supplied by a river nearby as the only source. This raw water is subject to a pre-treatment unit to remove the contaminants. This research was aimed to design a raw water pre treatment unit for utility in the power supply and to compare with the existing and operating treatment unit. The feed flow rate is 1,160 m<sup>3</sup>/hour. The design objective was to remove TSS, pathogenic bacteria, and turbidity using coagulation, flocculation, sedimentation, disinfectant, and ultra filtration membrane. Static mixer was used with pipe diameter 16 in. Flocculator has tubular size of (2x2) m<sup>2</sup> with 100 m length. Clarifier was a horizontal flow type with surface of (40x20) m<sup>2</sup> and depth 5,8 m. This clarifier has surface loading flow rate of 35 m<sup>3</sup>/m<sup>2</sup>.d, weir loading 250 m<sup>3</sup>/m.d with weir length of 111.4 m. Ultra-filtration membrane treats only 80% of feed water (50 lmh flux) and need surface area of 13,290 m<sup>2</sup>. From the comparison we found that we do not the screening. Furthermore, we should modify the flocculator and clarifier, and replace the sand filtration unit with ultra-filtration membrane.

**Keywords:** Water treatment, filtration, sedimentation, coagulation, flocculation and boiler feed.

### 1. Introduction

A power supply in Sawahlunto, West Sumatera takes water from Ombilin river

and treats the water for several purposes. Water fed to boiler should be free of mineral. Therefore, raw water undergoes pre treatments and finally goes to

demineralisation plant. Water goes through belt screen, static mixer, flocculator, clarifier, and sand filter. Pretreatment plays an important role prior to demineralisation to remove most of the organic and inorganic.

In the pretreatment stage, Aluminum sulphate ( $Al_2(SO_4)_3$ ), lime ( $Ca(OH)_2$ ), NaOCl, and a poly-electrolite are used to remove the suspended solid. Function of Alum as coagulant, lime as pH regulator, NaOCl as disinfektan, and polielektrolit as (coagulant aid) or flokulan. To re-activate raw water pre-treatment need a study again to the existing unit

## 2. Metodology

The objectives of this research is to obtain first design stage of raw Water pretreatment for Ombilin Steam Power Plant for utility by several process stage, include rapid mixing, low mixing and ultra filtration membrane. The equipments are designed for rapid mixing, sedimentation tank and ultra filtration for fine strain.

Raw water has strict requirements criteria, even more strict than requirement of domestic water. Boiler fed water must be free of mineral ingredients in raw water, therefore fed water must be proceed in deminerasation to remove mineral ingredients. Demineralisation can be run in several methods, one of them is ion exchange. The design is performed base on datas which has taken on site (the existing water pretreatment).others, asumption datas are used in calculation.

## 3. Result and discussion

Water pre-treatmentis located in Ombilin Steam Power Plant which used principle of coagulation, flocculatin, sedimentation, disinfektan, and filtration. Equipment used include static mixer, screen, pulsator clarifier and sand filter. Schematic process of water pretreatment is shown in Figure 1

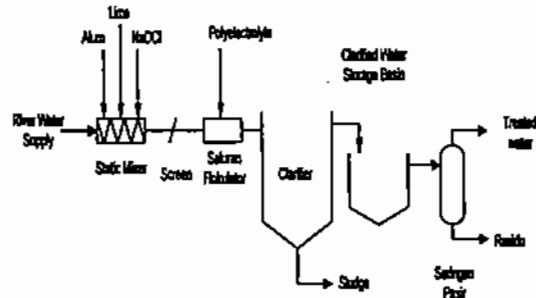


Figure 1.  
Pretreatment Process Schematics

The raw water from river is add with chemical coumpound which consist of alum, lime, natrium hipoklorit (NaOCl). The coumpound is feed to a static mixer.

Raw Water pretreatment in Steam power plant Ombilin produce water to fulfill need of demineralisation and other necessities such as service water, fire fighting water and cooling water. Most of ouput water of Clarifier (80%) need further treatment by using sand filter, others is used for system service, fire fighting and cooling water system. Sand filter produce water where fulfil requirement water feed for demineralisation. Quality of water output clarifier and output of sand filter are listed in Table 1.

Tabel 1.  
Quality of Water Output Clarifier

Parameter	value
Total Suspended Solid	< 5 mg/l
Turbidity	< 2 JTU
Free chlorine	0,1 – 1 mg/l

Tabel 2.  
Quality of Water Output of Sand Filter

Parameter	Nilai
Total Suspended Solid	< 1 mg/l
Turbidity	< 0,5 JTU
Free chlorine	0,1 – 0,5 mg/l

The design is summarized on table 3.

**Table 3.**  
Summary of Design Result

No.	Equipment	Spesification	Value
1	Static Mixer	Flow (Q)	1.160 m <sup>3</sup> /h
		Pipe Diameter (D)	16 in
		Velocity (v)	0,621 m/s
		Reynold Number (R)	3,02 x 10 <sup>6</sup>
2	Flocculator	Flow(Q)	1.160 m <sup>3</sup> /h
		Cross section (A)	4 m <sup>2</sup>
		Eometry of cross section G	(2 x 2) m <sup>2</sup>
		detenti on time(t)	20 minutes
		Volume (V)	386,4 m <sup>3</sup>
		Channel length (l)	100 m
3	Clarifier	Flow (Q)	1.160 m <sup>3</sup> /h
		Surface load velocity	35 m <sup>3</sup> /m <sup>2</sup> .d
		weir load velocity	250 m <sup>3</sup> /m.d
		Surface area (A)	795,4 m <sup>2</sup>
		Surface shape	(40 x 20) m <sup>2</sup>
		High (H)/ Depth	5,8 m
		Weir length	111,36 m
4	Ultra filtration membrane	fecd Flow (Q)	928 m <sup>3</sup> /day
		permeate flow	696 m <sup>3</sup> /day
		permeate flux(J)	50 l/m <sup>2</sup> per hour
		Surface area (A)	13.920 m <sup>2</sup>

There are several differences between design result with existing plant, the differences are the usage of screen, clarifier design, and the difference of the usage of sand filter and ultra filtration membrane.

*Flocculator channel*

The result of design shown that flocculator channel 100 meter in length and (2 x 2) m<sup>2</sup> cross section. Meanwhile on site, flocculator channel about 30 meter in

length with (1 x 1) m<sup>2</sup> in cross section. It cause imperfection in flocculation because detention is not sufficient

To improve performance of flocculation of operated water treatment units, flocculator channel should be modified. It could be modified as calculation result change, so that floc can be obtained and easy to form sediment.

*Clarifier Design*

Clarifier design as a result of calculation differ with existing clarifier on site. It is occured because basic operation is different. The design of clarifier use horizontal flow meanwhile exist plant special type of flow is clarifier pulsator vertical flow.

Pulsator system use fan to vacuum the vacuum chamber on surface of water. As fan cause chamber vacuum, the surface of water would flow up in vertical direction in the chamber. a moment, i.e. 40 seconds, then the vacuum would be released so that the surface of water would down immediately. 20 seconds then vacum chamber would be vacuum again and the process will be done countinuously base on certain time periods. It is combined with spread jet channel that exist in clarifier to form sludge as a result of pulsation system, they spread on the clarifier. By using this method, sedimentation process would be faster because flocs would not only form sediment because of gravitation but also force on pulsation process.

**4. Summary**

Water Pre-treatment Plant for the utility use coagulant principle, flocculation, sedimentation, and ultra filtration membrane need following equipments:

Mixer Static is to mix chemical compound, include alum as coagulant, lime as pH regulator, and NaOCl as disinfectant.

The operated Water pretreatment plant in PLTU Ombilin needs some modification.

Floculator channel need to modify to produce sufficient detention time in order to form better flocs. Pulsator clarifier should be replaced with horizontal flow clarifier. Sand filter should be replaced with ultra filtration where produce water with better quality.

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