







**DESIGN CRITERIA**
**DEMINERALIZATION PACKAGE**

**ENGINEERING TECHNICAL STANDARDS & PROCEDURES  
PT KILANG PERTAMINA INTERNASIONAL  
DIREKTORAT PROYEK INFRASTRUKTUR**

							
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## 1. INTRODUCTION

1.1 This Design Criteria establishes the minimum requirements for safe and reliable Design Criteria for Demineralization Package that meets the needs of Projects.

## 2. SCOPE

2.1 This Process design criteria covers document the minimum mandatory requirements of design criteria for the Demineralization Package required for operation with a lifetime of 20 years.

2.2 This document covers the general design criteria requirement of the new Demineralization Package.

## 3. CONFLICTS AND DEVIATIONS

3.1 Any conflicts between this standard and other applicable Engineering Technical Standards & Procedures (ETSP), or OWNER standard, codes, and forms shall be resolved in writing by OWNER.

3.2 All direct requests to deviate from this standard (ETSP) in writing to OWNER, who shall follow internal OWNER procedure and forward such requests to OWNER for approval.

## 4. ABBREVIATIONS

4.1 Abbreviations used for this document shall have the following definitions:

ASME	American Society of Mechanical Engineers
CO <sub>2</sub>	Carbon Di Oxide
CaCO <sub>3</sub>	Calcium Carbonate

## 1. PENGANTAR

1.1 Design Kriteria ini menetapkan persyaratan minimum yang aman dan memiliki nilai kehandalan untuk Design Kriteria terkait *Demineralization Package* yang memenuhi kebutuhan Proyek.

## 2. LINGKUP

2.1 Kriteria desain Proses ini mencakup dokumen persyaratan wajib minimum kriteria desain untuk Demineralization Package yang diperlukan untuk operasi dengan masa pakai 20 tahun.

2.2 Dokumen ini mencakup persyaratan kriteria desain umum dari Demineralization Package yang baru.

## 3. KONFLIK DAN DEVIASI

3.1 Apabila terdapat konflik antara standar ini dengan *Engineering Technical Standards & Procedures* (ETSP) yang berlaku lainnya, atau standar PEMILIK, codes dan formulir, maka harus diselesaikan secara tertulis oleh PEMILIK.

3.2 Semua permintaan penggunaan standar yang berbeda dari standar ini (ETSP), harus diajukan kepada PEMILIK secara tertulis dengan mengikuti prosedur internal PEMILIK untuk mendapatkan persetujuan.

## 4. SINGKATAN

4.1 Singkatan yang digunakan pada dokumen ini harus memiliki definisi sebagai berikut:

ASME	<i>American Society of Mechanical Engineers</i>
CO <sub>2</sub>	<i>Carbon Di Oxide</i>
CaCO <sub>3</sub>	<i>Calcium Carbonate</i>

ETSP	Engineering Technical Standards & Procedures	ETSP	<i>Engineering Technical Standards &amp; Procedures</i>
GPH	Gallon Per Hour	GPH	<i>Gallon Per Hour</i>
GPM	Gallon Per Minute	GPM	<i>Gallon Per Minute</i>
H <sub>2</sub> O	Water	H <sub>2</sub> O	<i>Water</i>
pH	Potens Hidrogen	pH	<i>Potens Hidrogen</i>
ppb	Part per billion	ppb	<i>Part per billion</i>
ppm	Part per million	ppm	<i>Part per million</i>
RDMP	Refinery Development Master Plan	RDMP	<i>Refinery Development Master Plan</i>
TDS	Total Dissolved Solids	RU	<i>Total Dissolved Solids</i>

## 5. DEFINITIONS

5.1 The following words shall have these special meanings when used herein:

<b>OWNER</b>	Owner of the Plant is defined as PT Kilang Pertamina Internasional.
<b>CONTRACTOR/ CONSULTANT</b>	Defined as The Organization to which PT Kilang Pertamina Internasional assign the work.
<b>shall</b>	Indicates that the statement is mandatory.
<b>should</b>	Indicates a recommendation.
<b>Caustic</b>	A Chemical substance when it is added in small concentration to an environment such as acidic water, it effectively control of pH in water handling

## 5. DEFINISI

5.1 Penggunaan kata-kata berikut harus memiliki arti khusus sebagai berikut:

<b>PEMILIK</b>	Pemilik Kilang didefinisikan sebagai PT Kilang Pertamina Internasional.
<b>KONTRAKTOR/ KONSULTAN</b>	Didefinisikan sebagai Organisasi yang ditunjuk oleh di PT Kilang Pertamina Internasional untuk melakukan suatu pekerjaan.
<b>shall</b>	Menunjukkan bahwa pernyataan itu wajib.
<b>should</b>	Menunjukkan rekomendasi.
<b>Caustic</b>	Zat kimia yang ketika ditambahkan dalam konsentrasi kecil ke <i>environment</i> seperti <i>acidic water</i> , secara efektif mengontrol pH

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system.

Sulfuric Acid A Chemical substance when it is added in small concentration to an environment such as alkaline water, it effectively control of pH in water handling system

*water handling system.*

Asam Sulfat Zat kimia yang ketika ditambahkan dalam konsentrasi kecil ke *environment* seperti *alkaline water*, secara efektif mengontrol pH dalam sistem penanganan air.

## 6. STANDARD & CODE AND REFERENCE DOCUMENTS

The following Codes, Standard and Specifications apply to this specification. When an edition date is not indicated for a code or standard or any update in codes and standards in this specification document, the latest edition and addendum in force at the time of purchase shall apply. Material & equipment shall be as a specification or an equal approved by OWNER.

### 6.1 American Society of Mechanical Engineers

ASME VIII Div. 1 Boiler and Pressure Vessel Code

## 6. STANDAR & KODE DAN DOKUMEN REFERENSI

Kode, standar, dan spesifikasi berikut berlaku untuk spesifikasi ini. Kode dan standar harus menggunakan edisi yang terbaru atau edisi yang berlaku pada saat pembelian. Material & peralatan harus sesuai spesifikasi atau setara dengan yang disetujui oleh PEMILIK.

### 6.1 *American Society of Mechanical Engineers*

ASME VIII Div. 1 *Boiler and Pressure Vessel Code*

## 7. CRITERIA DESIGN

### 7.1 General

This Design Criteria document covers the water demineralization applies of Polishing ion exchange system using cation-anion exchange resin for Desalinated Water as feed in the Refinery Unit. Chemicals also used for utility purposes for treating water purposes also is discussed. This Design Criteria document covers the Demineralization Package equipment vessels, piping and appurtenances comprising a water demineralization

## 7. KRITERIA DESAIN

### 7.1 Umum

Dokumen Kriteria Desain ini mencakup aplikasi *water demineralization* dari *Polishing ion exchange system* menggunakan *cation-anion exchange resin for Desalinated Water* sebagai feed di Unit Penyulingan. Bahan kimia yang juga digunakan untuk keperluan utilitas untuk *treating water* juga dibahas. Dokumen Kriteria Desain ini mencakup *Demineralization Package equipment vessels*, perpipaan dan perlengkapan

system, but does not discuss the detailed design of the equipment comprising these systems.

## 7.2 Demineralization Package Equipment

Mix-bed Polishing vessels completed with ion exchange resins and chemicals injection package also pumps are the most commonly used.

A process which cations dissolved in water are exchanged for hydrogen ions, while dissolved anions are exchanged for hydroxide ions; both together react to water. Ion exchangers are regenerated with acids and caustics. Accordingly, the operation of ion exchange plants requires equipment for storing and handling of chemicals, as well as equipment for effluent neutralization. With a given plant design, both the chemical consumption and the effluent discharge are directly proportional to the total dissolved solids (TDS) concentration of the raw water.

A demineralizer is a system, which uses an ion exchange chemical process to remove dissolved ionic compounds (salts) from water. It is also known as Deionized Water System, Demineralizer or DM Plant.

Demineralization Package have 2 Type, 1(One) Vessel and 2 (two) vessels.

Type of Demineralization Package uses 1(one) vessel is called Mix-Bed Polisher, which combines Cation and Anion exchangers in a single column. When it comes to requiring high-purity Demineralized Water, mixed bed demineralizer is considered more efficient in many ways. It is used as polishing unit to purify water to higher levels, which is

yang terdiri dari sistem *water demineralization*, tetapi tidak membahas desain rinci peralatan yang terdiri dari sistem ini.

## 7.2 Peralatan *Demineralization Package*

*Mix-bed Polishing vessels* yang dilengkapi dengan *ion exchange resins* dan *chemicals injection package* serta pompa adalah yang paling umum digunakan.

Suatu proses dimana kation yang dilarutkan dalam air ditukar dengan ion hidrogen, sedangkan anion terlarut ditukar dengan ion hidroksida; keduanya bersama-sama bereaksi terhadap air. *Ion exchangers* diregenerasi dengan asam dan *caustics*. Oleh karena itu, pengoperasian kilang *ion exchangers* memerlukan peralatan untuk menyimpan dan menangani bahan kimia, serta peralatan untuk effluent neutralization. Dengan desain instalasi yang diberikan, konsumsi bahan kimia dan pembuangan limbah berbanding lurus dengan konsentrasi *total dissolved solids (TDS) raw water*.

*Demineralizer* adalah sistem yang menggunakan *ion exchange chemical process* untuk menghilangkan senyawa ionik terlarut (garam) dari air. Ini juga dikenal sebagai *Deionized Water System, Demineralizer* atau *DM Plant*.

*Demineralization Package* memiliki 2 Tipe, 1(Satu) vessel dan 2 (dua) vessel.

Tipe *Demineralization Package* menggunakan 1 (satu) vessel yang disebut *Mix-Bed Polisher*, yang menggabungkan *Cation* dan *Anion exchangers* dalam satu kolom. Ketika dating membutuhkan *high-purity Demineralized Water*, *mixed bed demineralizer* dianggap lebih efisien dalam banyak hal. Ini digunakan sebagai

treated through Two Bed demineralizer or Reverse Osmosis Unit at earlier stage.

Type of Demineralization Package uses 2(two) vessels, which the feed water or raw water is passed through first vessel i.e. containing strong base cation resin in the form of Hydrogen (H<sup>+</sup>), whereupon all the positively charged ions (sodium, calcium, iron and copper etc.) are exchanged for Hydrogen ions; after that, the water further passed through another vessel containing strong base anion resin in the form of Hydroxyl (OH<sup>-</sup>), where upon all the negatively charged ions (chloride, sulphate, nitrate, etc) are exchanged for hydroxide ions which then combine with the hydrogen ions to form water.

Often called Dual Bed, Two Bed Demineralizers have the cation resin and anion resin in separate vessels. They can be regenerated in series (cation followed by anion); or in parallel (cation and anion simultaneously). Anion resin must have the hardness removed from the influent water to prevent hardness fouling. The Cation resin is regenerated with acid (hydrochloric or sulfuric), and the Anion resin is regenerated with sodium hydroxide (caustic soda).

Two Bed Demineralizers normally produce water quality in the range of 50,000 ohms up to 200,000 ohms resistivity, which is between 8.5 and 2.0 ppm TDS as CaCO<sub>3</sub>. Automatic mixed deionizers utilize the same resins but mix the two resins for use. This produces a significantly higher purity than a two-column design, up to 18 megaohm.

*polishing unit* untuk memurnikan air ke tingkat yang lebih tinggi, yang diolah melalui *Two Bed demineralizer* atau Unit Reverse Osmosis pada tahap sebelumnya.

Tipe *Demineralization Package* menggunakan 2(dua) vessels, dimana *feed water* atau *raw water* dilewatkan melalui *vessel* pertama yaitu berisi *strong base cation resin* berupa Hidrogen (H<sup>+</sup>), dimana semua ion bermuatan positif (natrium, kalsium, besi) dan tembaga dll.) ditukar dengan ion Hidrogen; setelah itu, air selanjutnya melewati *vessel* lain yang berisi *strong base anion resin* berupa Hidroksil (OH<sup>-</sup>), dimana pada semua ion bermuatan negatif (klorida, sulfat, nitrat, dll) ditukar dengan ion hidroksida yang kemudian bergabung dengan ion hidrogen untuk membentuk air.

Sering disebut *Dual Bed, Two Bed Demineralizers* memiliki resin kation dan resin anion dalam *vessel* terpisah. Mereka dapat diregenerasi secara seri (kation diikuti oleh anion); atau paralel (kation dan anion secara bersamaan). Resin anion harus memiliki *hardness* yang dihilangkan dari *influent water* untuk mencegah *hardness fouling*. Resin Kation diregenerasi dengan asam (hidroklorik atau sulfat), dan resin Anion diregenerasi dengan natrium hidroksida (*caustic soda*).

*Two Bed Demineralizers* biasanya menghasilkan kualitas air pada kisaran resistivitas 50.000 ohm hingga 200.000 ohm, yaitu antara 8,5 dan 2,0 ppm TDS sebagai CaCO<sub>3</sub>. *Automatic mixed deionizers* menggunakan resin yang sama tetapi mencampur dua resin untuk digunakan. Ini menghasilkan kemurnian yang jauh lebih tinggi daripada desain dua kolom, hingga 18 megaohm.

Demineralization Package with 1(one) vessel is proven more efficient in many ways.

*Demineralization Package dengan 1(one) vessel terbukti lebih efisien dalam banyak hal.*

### 7.3 Process Design Data Requirements

- a. Feed water is Desalinated water (Flow rate and specification)
- b. Product Required Specification (flow rate & specification)
- c. Feed water condition (Pressure and Temperature)
- d. Regeneration System requirements (Service time per vessel, effluents condition)
- e. Utility Conditions (Instrument Air Pressure and Temperature, Electric Power, Demineralization water; Desalinated Water)
- f. System Configuration
- g. Design Capacity of Package
- h. Chemical requirements (consumption, concentration and specification).

### 7.3 Persyaratan *Process Design Data*

- a. *Feed water* adalah *Desalinated water (Flow rate dan specification)*
- b. *Product Required Specification (flow rate & specification)*
- c. Kondisi *Feed water* (Tekanan dan Suhu)
- d. *Regeneration System requirements (Service time per vessel, effluents condition)*
- e. *Utility Conditions (Instrument Air Pressure dan suhu, Electric Power, Demineralization water; Desalinated Water)*
- f. *System Configuration*
- g. Kapasitas Desain *Package*
- h. *Chemical requirements (consumption, concentration dan specification).*

### 7.4 Polisher Vessel

Polisher vessel shall be design as Standard Design from ASME BPV Section VIII Div.1 Latest Edition.

### 7.4 *Polisher Vessel*

*Polisher vessel* harus didesain sesuai Desain Standar dari ASME BPV Bagian VIII Div.1 Edisi Terbaru.

### 7.5 Design Criteria for Ion Exchange Resin System

### 7.5 Kriteria Desain untuk *Ion Exchange Resin System*

#### 7.5.1. Regeneration System Selection

There are 2(two) type of Ion Exchange Resin Regeneration System, namely, Counter Current Regeneration System and Co-current Regeneration System.

#### 7.5.1. Pemilihan *Regeneration System*

Ada 2 (dua) jenis *Ion Exchange Resin Regeneration System*, yaitu *Counter Current Regeneration System* dan *Co-current Regeneration System*.

#### 7.5.1.1. Counter Current Regeneration Systems

In these systems, the regenerant

#### 7.5.1.1. *Counter Current Regeneration Systems*

Dalam sistem ini, *regenerant*

is applied in the opposite direction to the service flow, resulting in reduced chemical consumption, improved water quality and fewer waste volumes compared to traditional co-current regenerated systems.

Counter-current regeneration systems should provide a water quality of better than 2  $\mu\text{S}/\text{cm}$  (0.5 MW.cm) and residual silica of 0.020 to 0.050 mg/l as  $\text{SiO}_2$ . Depending upon water composition and regeneration conditions, the specific conductivity could be as low as 0.2  $\mu\text{S}/\text{cm}$  (5 MW.cm).

The normal counter-current endpoint is 4  $\mu\text{S}/\text{cm}$  conductivity. A maximum endpoint value of 0.3 mg/l  $\text{SiO}_2$  above the average leakage should not be exceeded to avoid high contamination of the polishing resin layer and unacceptably high silica leakage during subsequent cycles.

Silica leakage can be minimized by operating the plant at silica break rather than conductivity end point. This secures the lowest silica leakage, but at the expense of a 5 -10 % throughput reduction.

There are two main types of counter-current systems:

- a) Blocked Systems (including air hold down, water hold down and inert mass blocked).

The service flow is downwards and regeneration up the flow.

diterapkan dalam arah yang berlawanan dengan *service flow*, menghasilkan pengurangan konsumsi bahan kimia, peningkatan kualitas air, dan volume limbah yang lebih sedikit dibandingkan dengan *traditional co-current regenerated systems*.

*Counter-current regeneration systems* harus memberikan kualitas air yang lebih baik dari 2  $\mu\text{S}/\text{cm}$  (0,5 MW.cm) dan silika residual 0,020 hingga 0,050 mg/l sebagai  $\text{SiO}_2$ . Tergantung pada komposisi air dan kondisi regenerasi, konduktivitas spesifik bisa serendah 0,2  $\mu\text{S}/\text{cm}$  (5 MW.cm).

*Normal counter-current endpoint* adalah 4  $\mu\text{S}/\text{cm}$  *conductivity*. Nilai Maximum endpoint 0,3 mg/l  $\text{SiO}_2$  di atas *leakage* rata-rata tidak boleh dilampaui untuk menghindari kontaminasi yang tinggi pada *polishing resin layer* dan *leakage* silika yang sangat tinggi selama siklus berikutnya.

*Silica leakage* dapat diminimalkan dengan mengoperasikan kilang pada saat *silica break* daripada *conductivity end point*. Hal ini mengamankan *Silica leakage* terendah, tetapi dengan mengorbankan pengurangan *throughput* 5 -10%.

Terdapat dua jenis utama *counter-current systems*:

- a) *Blocked Systems* (termasuk *air hold down, water hold down* dan *inert mass blocked*).

*Service flow* ke bawah dan regenerasi *up the flow*. Untuk

To avoid disturbance of the resin polishing zone at the bottom of the vessel, the resin bed is held down (blocked) during regeneration by air pressure, water flow or an inert mass in the top part of the vessel. The regenerant passes up through the resin and out of a collector system in the middle part of the vessel. Such systems have similar high cylindrical height as co-current systems to allow resin backwash within the vessel.

b) Packed Bed Systems

These may be up-flow service with down-flow regeneration or down-flow service with up-flow regeneration. Currently, this type is very popular due to more efficient in such ways.

7.5.1.2. Co-Current Regeneration Systems

These are the simplest systems, where the resin is regenerated in the same direction as the service flow (downwards). The vessel has a large freeboard to the resin bed expansion when backwashing is carried out to remove suspended solids and resin fines. Co-current regeneration single bed systems will generally produce water of much lower quality than counter-current systems, with typical leakage values ~10 times higher. Such quality will also be even more affected by the water composition, the type of regenerant chemical and dosage

menghindari gangguan pada *resin polishing zone* di bagian bawah *vessel*, *resin bed* ditahan (*blocked*) selama regenerasi oleh tekanan udara, aliran air atau *inert mass* di bagian atas *vessel*. Regeneran melewati resin dan keluar dari *collector system* di bagian tengah *vessel*. Sistem seperti itu memiliki tinggi silinder yang sama dengan *co-current systems* untuk memungkinkan *resin backwash* di dalam *vessel*.

b) Packed Bed Systems

Ini mungkin *up-flow service* dengan regenerasi *down-flow* atau *down-flow service* dengan regenerasi *up-flow*. Saat ini, tipe ini sangat populer karena lebih efisien dengan cara seperti itu.

7.5.1.2. Co-Current Regeneration Systems

Ini adalah sistem yang paling sederhana, di mana resin diregenerasi dalam arah yang sama dengan *service flow* (ke bawah) *Vessel* memiliki freeboard besar untuk memungkinkan ekspansi *resin bed* saat backwashing dilakukan untuk menghilangkan padatan tersuspensi dan resin halus. Cocurrent regeneration single bed systems umumnya akan menghasilkan air dengan kualitas yang jauh lebih rendah daripada *countercurrent systems*, dengan nilai *leakage* tipikal ~10 kali lebih tinggi. Kualitas tersebut juga akan

being used.

This system is less efficient than counter current regeneration system.

#### 7.5.2. Selection of Layout and Resin Type (Configuration)

The plant configuration will depend on the feed water composition, the water quality required and the economics of operation.

There are 5 (five) Resin Type that IS used commonly in the Demineralization Package.

- a) Strong Acid Cation Resin
- b) Weak Acid Cation Resin
- c) Strong Base Anion Resin Type I
- d) Strong Base Anion resin Type II
- e) Weak Base Anion Resin

Each type is explained below:

##### a) Strong Acid Cation Resin

Strong Acid Cation Resin is used for water softening in the Na cycle and for demineralization when the temporary hardness in the feed is < 40%. For small plants and with HCl as regenerant, a strong acid cation also offers a simple effective solution on waters with > 40% temporary hardness.

##### b) Weak Acid Cation Resin

Weak Acid Cation Resin is used as a single resin for de-

lebih dipengaruhi oleh komposisi air, jenis bahan kimia regeneran dan dosis yang digunakan.

Sistem ini kurang efisien dibandingkan dengan *counter current regeneration system*.

#### 7.5.2. Selection of Layout and Resin Type (Configuration)

Konfigurasi kilang akan tergantung pada komposisi *feed water*, kualitas air yang dibutuhkan dan keekonomisan operasi.

Terdapat 5 (lima) Jenis Resin yang biasa digunakan dalam *Demineralization Package*.

- a) *Strong Acid Cation Resin*
- b) *Weak Acid Cation Resin*
- c) *Strong Base Anion Resin Type I*
- d) *Strong Base Anion resin Type II*
- e) *Weak Base Anion Resin*

Masing-masing jenis dijelaskan di bawah ini:

##### a) *Strong Acid Cation Resin*

*Strong Acid Cation Resin* digunakan untuk *water softening* dalam siklus Na dan untuk *demineralization* ketika *temporary hardness* dalam *feed* < 40%. Untuk kilang kecil dan dengan HCl sebagai *regenerant*, *strong acid cation* juga menawarkan solusi sederhana yang efektif pada air dengan *temporary hardness* > 40%.

##### b) *Weak Acid Cation Resin*

*Weak Acid Cation Resin* digunakan sebagai *single resin*

alkalization in the H cycle and brackish water softening in the Na cycle. In demineralization, the use of a weak acid cation in front of a strong cation is preferred with feed waters containing a high proportion of temporary hardness (>40%) and low FMA. This configuration has advantages in terms of regeneration efficiency and operating capacity.

With sulfuric acid regeneration, two separate cation columns should be used to allow acid dilution at the weak acid resin inlet. For counter-flow regeneration, a double compartment layered bed cation including a facility for acid dilution at the weak acid cation inlet can be used, but is more complex to operate.

c) Strong Base Anion Resin Type I

Strong Base Anion Resin Type I as a single resin is particularly recommended for treating low FMA (Free Mineral Acid) water with high silica and where low silica leakage is required (~20 ppb in counter-current operation). The resin can be regenerated up to 50°C (122°F) for more effective silica removal.

*for de-alkalization* pada siklus H dan untuk *brackish water softening* pada siklus Na. Dalam *demineralization*, penggunaan *Weak Acid Cation* di depan *strong cation* lebih disukai dengan *feed water* yang mengandung proporsi *temporary hardness* yang tinggi (>40%) dan FMA rendah. Konfigurasi ini memiliki keunggulan dalam hal efisiensi regenerasi dan kapasitas operasi.

Dengan regenerasi asam sulfat, dua kolom kation terpisah harus digunakan untuk memungkinkan pengenceran asam pada *weak acid resin inlet*. Untuk *counter-flow regeneration*, *double compartment layered bed cation* termasuk fasilitas untuk pengenceran asam pada *weak acid resin inlet* dapat digunakan, tetapi pengoperasiannya lebih kompleks.

c) *Strong Base Anion Resin Type I*

*Strong Base Anion Resin Type I* sebagai single resin sangat direkomendasikan untuk mengolah air FMA (Free Mineral Acid) rendah dengan silica tinggi dan di mana *low silica leakage* diperlukan (~20 ppb dalam counter-current operation). Resin dapat diregenerasi hingga 50°C (122°F) untuk penghilangan silica yang lebih efektif.

## d) Strong Base Anion Resin Type II

Strong Base Anion Resin Type II is well suited for small plants, owing to its excellent regeneration efficiencies for water compositions where CO<sub>2</sub> and SiO<sub>2</sub> are < 30% of the total feed anions. Type II anions have a much better operating capacity and regeneration efficiency compared to Type I but are limited to lower temperature operation (<35°C/95°F caustic treatment) and have a higher SiO<sub>2</sub> leakage (~50 ppb in counter-current operation).

## e) Weak Base Anion Resin

Weak Base Anion Resin is used as a single resin to obtain partially deionized water without the removal of CO<sub>2</sub> and SiO<sub>2</sub>. For complete demineralization, the combination of a weak base and strong base anion is an excellent choice for larger plants, as it provides optimum operation costs. The weak base has very high regeneration efficiency and provides additional capacity to the system. The weak and strong anion combination is well suited to treat waters with low alkalinity or degassed feed, when the FMA (Cl + NO<sub>3</sub> + SO<sub>4</sub>) is, typically, > 60% of the total anions.

Weak base anions are particularly effective in handling natural organics, which are

d) *Strong Base Anion Resin Type II*

Strong Base Anion Resin Type II sangat cocok untuk kilang kecil, karena efisiensi regenerasinya yang sangat baik untuk komposisi air di mana CO<sub>2</sub> dan SiO<sub>2</sub> < 30% dari total feed anion. Anion Type II memiliki kapasitas operasi dan efisiensi regenerasi yang jauh lebih baik dibandingkan dengan Type I tetapi terbatas pada operasi suhu yang lebih rendah (caustic treatment <35°C/95°F) dan memiliki SiO<sub>2</sub> leakage yang lebih tinggi (~50 ppb pada counter-current operation).

e) *Weak Base Anion Resin*

digunakan sebagai *single resin* untuk mendapatkan *deionized water* sebagian tanpa menghilangkan CO<sub>2</sub> dan SiO<sub>2</sub>. Untuk *demineralization* lengkap, kombinasi *weak base* dan *strong base anion* adalah pilihan yang sangat baik untuk kilang yang lebih besar, karena memberikan biaya operasi yang optimal. *Weak base* memiliki efisiensi regenerasi yang sangat tinggi dan memberikan kapasitas tambahan ke sistem. Kombinasi *weak* dan *strong anion* cocok untuk mengolah air dengan alkalinitas rendah atau *degassed feed*, ketika FMA (Cl + NO<sub>3</sub> + SO<sub>4</sub>) biasanya > 60% dari total anion.

*Weak base anions* sangat efektif dalam menangani *natural organics*, yang biasanya

usually high molecular weight weakly acidic compounds that affect both weak base and strong base anion resins. In a weak base - strong base anion configuration, some of the organics will pass through the weak to the strong base. The design should therefore account for SBA organic loading at the end of the cycle, as the resin will require additional NaOH to desorb the organics. There are important differences in loading capacity or reversibility to organics between different anion types.

The weak and strong anion resins can either be designed in two separate vessels or for counter-flow regeneration in one vessel with or without a separation nozzle plate.

### 7.5.3. Chemical Efficiencies for Different Resin Configuration

As the resin usage of the regenerant chemical is non-ideal, the chemical efficiency is always >100%. The efficiency therefore becomes worse as the value increases. The following table gives typical regeneration efficiencies for different resin types and combinations in co-current and counter-current regeneration systems.

Resin Type/Configuration	Regeneration System	Typical Regeneration Efficiency (%)
Strong Acid Cation	Co Current HCl	200-250

merupakan senyawa asam lemah dengan berat molekul tinggi yang mempengaruhi *weak base* dan *strong base anion resins*. Dalam konfigurasi *weak base - strong base*, beberapa bahan organik akan melewati *weak base* ke *strong base*. Oleh karena itu, desain harus memperhitungkan *SBA organic loading* pada akhir siklus, karena resin akan membutuhkan tambahan NaOH untuk mendesorpsi bahan organik. Ada perbedaan penting dalam *loading capacity* atau reversibilitas organik antara jenis anion yang berbeda.

Weak dan strong anion resins apat didesain dalam vessel terpisah atau untuk counter-flow regeneration dalam satu vessel dengan atau tanpa separation nozzle plate.

### 7.5.3. Efisiensi Bahan Kimia untuk Konfigurasi resin berbeda

Karena penggunaan resin regenerant chemical tidak ideal, efisiensi kimia selalu >100%. Efisiensi karena itu menjadi lebih buruk seiring nilai meningkat. Tabel berikut memberikan efisiensi regenerasi tipikal untuk jenis resin yang berbeda dan kombinasi dalam co-current dan counter-current regeneration systems.

	Counter Current HCl	120-150
	Co Current H <sub>2</sub> SO <sub>4</sub>	250-300
	Counter Current H <sub>2</sub> SO <sub>4</sub>	150-200
Weak Acid Cation		105-115
Weak Acid + Strong Acid Cation		105-115
Strong Base Anion Type I	Co Current	250-300
	Counter Current	140-220
Strong Base Anion Type II	Co Current	150-200
	Counter Current	125-140
Weak Base Anion		120-150
Layered Base Anion		120-130

#### 7.5.4. Atmospheric Degassifier

The decision to install an atmospheric degassifier is principally economic. Removing carbon dioxide before it reaches the anion resins will reduce NaOH chemical consumption and this should be balanced against the cost of the degassifier. Generally, the economical balance is not in favor of a degassifier for small plants (up to about 10 m<sup>3</sup>/h or 45 gpm). For larger plants, if the total CO<sub>2</sub> is greater than 50-100 mg/l (ppm), the pay-back time for a degassifier should be short.

Atmospheric degassifiers usually reduce residual CO<sub>2</sub> down to 5 mg/l. In order to have a safety margin for design, a residual value of 10 mg/l CO<sub>2</sub> is recommended.

For systems requiring very low levels of residual CO<sub>2</sub>, a vacuum

#### 7.5.4. Atmospheric Degassifier

Keputusan untuk memasang *atmospheric degassifier* pada prinsipnya ekonomis. Menghilangkan karbon dioksida sebelum mencapai resin anion akan mengurangi konsumsi kimia NaOH dan ini harus diimbangi dengan biaya *degassifier*. Umumnya keseimbangan ekonomi tidak mendukung *degassifier* untuk kilang kecil (sampai sekitar 10 m<sup>3</sup>/jam atau 45 gpm). Untuk kilang yang lebih besar, jika total CO<sub>2</sub> lebih besar dari 50-100 mg/l (ppm), *pay-back time* untuk degassifier harus singkat.

Atmospheric *degassifiers* biasanya mengurangi sisa CO<sub>2</sub> hingga 5 mg/l. Untuk *safety margin* untuk desain, nilai residu 10 mg/l CO<sub>2</sub> direkomendasikan.

Untuk sistem yang membutuhkan tingkat residu CO<sub>2</sub> yang sangat

degassifier is used. This reduces the CO<sub>2</sub> to below 1 mg/L.

#### 7.5.5. Resin Operating Capacities and Regenerant Levels

In co-current operation, the product water quality requirements will define the minimum levels of acid and caustic regenerant to be used. The regenerant levels and the feed water composition will then define the resin operating capacity. Although high regenerant levels result in increased capacity and lower ionic leakages, the chemical efficiency of the system becomes worse.

Guidelines for Typical Regeneration Level and Corresponding Resin Operating Capacity:

Regeneration System Capacity	Regenerant Level		Typical Operating	
	(g/l)	(lbs/ft <sup>3</sup> )	(g/l)	(lbs/ft <sup>3</sup> )
Co Current Regeneration				
HCl	80-120	5 – 7.5	0.8 – 1.2	17.5–26
H <sub>2</sub> SO <sub>4</sub>	150-200	9.5 – 12.5	0.5 – 0.8	11-17.5
NaOH	80-120	5 – 7.5	0.4 – 0.6	8.5-12
Counter Current Regeneration				
HCl	40-55	2.5-3.5	0.8-1.2	17.5-26
H <sub>2</sub> SO <sub>4</sub>	60-80	3.75-5	0.5-0.8	11-17.5
NaOH	30-45	2-2.8	0.4-0.6	8.5-13

The choice between hydrochloric acid and sulfuric acid is principally economic. HCl is a trouble-free regenerant with high efficiency. H<sub>2</sub>SO<sub>4</sub> is less efficient and has lower operating capacity,

rendah, digunakan *vacuum degassifier*. Hal ini mengurangi CO<sub>2</sub> hingga di bawah 1 mg/L.

#### 7.5.5. Kapasitas Operasi Resin dan Level Regeneran

Pada *co-current operation*, persyaratan kualitas *product water* akan menentukan tingkat minimum *acid* dan *caustic regenerant* yang akan digunakan. Tingkat regeneran dan komposisi *feed water* kemudian akan menentukan kapasitas operasi resin. Meskipun tingkat regeneran yang tinggi menghasilkan peningkatan kapasitas dan *ionic leakages* yang lebih rendah, efisiensi kimia sistem menjadi lebih buruk.

Pedoman untuk Tingkat Regenerasi Tipikal dan Kapasitas Operasi Resin yang Sesuai:

*Pilihan antara hydrochloric acid dan sulfuric acid pada dasarnya bersifat ekonomis. HCl adalah regenerant bebas masalah dengan efisiensi tinggi. H2SO4 kurang efisien dan memiliki kapasitas operasi yang*

particularly if stepwise regeneration is required in high hardness waters to avoid calcium sulfate precipitation.

Guidelines for amounts and concentrations of H<sub>2</sub>SO<sub>4</sub> in stepwise regeneration:

*lebih rendah, terutama jika regenerasi bertahap diperlukan di high hardness waters untuk menghindari pengendapan kalsium sulfat.*

Pedoman untuk jumlah dan konsentrasi H<sub>2</sub>SO<sub>4</sub> dalam regenerasi bertahap:

Calcium in Feed Water (%)	Amount and Concentration of H <sub>2</sub> SO <sub>4</sub>
Ca < 15	3%
15 < Ca < 50	1/3 at 1.5% and 2/3 at 3%
50 < Ca < 70	1/2 at 1.5% and 1/2 at 3%
Ca > 70	1% or use HCl

The specifications on the purity of the regeneration chemicals have to assure a trouble-free operation of the ion exchange resins after regeneration. Recommendations on the quality of regeneration chemicals (12KB PDF) are given.

In order to compensate for non-ideal operating conditions and resin aging on a working plant, it is recommended to apply a safety factor to operating capacity figures. Typical safety margins are 5% for cations and 10% for anions. Once the operating capacity has been determined, the required resin volume can be calculated from the throughput (volume treated per cycle) as follows:

#### 7.5.6. Vessel Sizing

The vessels should be made from typical, well-known materials of construction such as rubber-lined carbon steel or fiberglass. The vessel should have distribution / collector systems that give a good

Spesifikasi kemurnian *regeneration chemicals* harus memastikan *trouble-free operation* dari *ion exchange resins* setelah regenerasi. Rekomendasi tentang kualitas bahan kimia regenerasi (12KB PDF) diberikan.

Untuk mengimbangi kondisi operasi yang tidak ideal dan resin aging pada kilang yang bekerja, disarankan untuk menerapkan faktor keamanan pada operating capacity figures. Safety margins tipikal adalah 5% untuk kation dan 10% untuk anion. Setelah kapasitas operasi ditentukan, volume resin yang dibutuhkan dapat dihitung dari throughput (volume yang diolah per siklus) sebagai berikut:

#### 7.5.6. Vessel Sizing

*Vessels* harus dibuat dari material konstruksi tipikal dan terkenal seperti *rubber-lined carbon steel* atau *fiberglass*. *Vessel* harus memiliki sistem distribusi/ kolektor yang memberikan distribusi cairan

distribution of fluids during all phases of the operation. For this reason, a maximum vessel diameter of 3.5m (11.5 feet) is recommended. It is advisable to install sight-glasses to check resin levels and separation in the case of layered beds and mixed beds.

The design of the vessels should give a maximum resin bed depth, while limiting the pressure drop across the resin bed to ~1 bar. The optimum column diameter must be a balance between the resin bed height, the ratio of resin height to diameter (H/D) and the linear velocity. H/D should be in the range of 2/3 to 3/2.

Vessel sizing should be adjusted to allow for resin expansion if backwashing is performed (80-100% of the settled resin bed height), resin swelling during service, the minimum bed height requirements and the guidelines given for service and regenerant flow rates in the Design Guidelines table below. These values are for orientation and should not be regarded as exclusive. Some applications may function outside of the guidelines. Typical resin bed depth is 1.2 m (4 ft) for co-current and blocks regeneration systems and 2 m (6.5 ft) for counter-current packed bed systems.

Design Guidelines for Operating Resins.

yang baik selama semua fase operasi. Untuk alasan ini, diameter vessel maksimum 3,5m (11,5 kaki) direkomendasikan. Dianjurkan untuk memasang *sight-glasses* untuk memeriksa *resin level* dan pemisahan dalam hal *layered beds* dan *mixed beds*.

Desain vessel harus memberikan *maximum resin bed depth*, sambil membatasi penurunan tekanan pada lapisan *resin bed* hingga ~1 bar. Diameter kolom optimum harus seimbang antara tinggi *resin bed*, rasio tinggi resin terhadap diameter (H/D) dan kecepatan linier. H/D harus dalam kisaran 2/3 hingga 3/2.

Vessel sizing harus disesuaikan untuk memungkinkan ekspansi resin jika backwashing dilakukan (80-100% dari settled resin bed height), resin swelling selama servis, persyaratan bed height minimum dan pedoman yang diberikan untuk servis dan regenerant flow rates dalam Desain Tabel panduan di bawah ini. Nilai-nilai ini untuk orientasi dan tidak boleh dianggap eksklusif. Beberapa aplikasi mungkin berfungsi di luar pedoman. Typical resin bed depth adalah 1,2 m (4 kaki) untuk co-current dan blocks regeneration systems dan 2 m (6,5 kaki) untuk counter-current packed bed systems.

Pedoman Desain untuk Pengoperasian Resin.

Swelling:

Strong Acid Cation Na <sup>+</sup> → H <sup>+</sup>	5-8%
Weak Acid Cation H <sup>+</sup> → Ca <sup>+</sup>	15-20%
Strong Base Anion Cl <sup>-</sup> → OH <sup>-</sup>	15-25%
Weak Base Anion FB → HCl	15-25%

Swelling:

Bed depth, min.

Co-current single resin	800 mm (2.6 ft)
Counter-current single resin	1200 mm (4 ft)
Layered bed strong base anion	800 mm (2.6 ft)
Layered bed weak base anion	600 mm (2 ft)

*Bed depth, min.*

Backwash flow rate:

Strong Acid Cation	10-25 m/h (4-10 gpm/ft <sup>2</sup> )
Weak Acid Cation	10-20 m/h (4-8 gpm/ft <sup>2</sup> )
Strong Base Anion	5-15 m/h (2-6 gpm/ft <sup>2</sup> )
Weak Base Anion	3-10 m/h (1.2-4 gpm/ft <sup>2</sup> )

*Backwash flow rate:*

Flow rates:

Service/ fast rinse	5-60 m/h (2-24 gpm/ft <sup>2</sup> )
Service/ condensate polishing	75-120 m/h (30-50 gpm/ft <sup>2</sup> )
Co-current regeneration/ displacement rinse	1-10 m/h (0.4-4 gpm/ft <sup>2</sup> )
Counter-current regeneration/ displacement rinse	5-20 m/h (2-8 gpm/ft <sup>2</sup> )

*Flow rates:*

Total Rinse requirements:

Strong Acid Cation	2-6 Bed volumes	
Weak Acid Cation	3-6 Bed volumes	

Total Rinse requirements:

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Strong Base Anion	3-6 Bed volumes	
Weak Base Anion	2-4 Bed volumes <sub>[RD1][RD2]</sub>	

#### 7.5.7. Number of Lines

Based on the flow rate and throughput required, the number of lines operating at the same time needs to be defined. The simplest layout with 2 lines (1 in operation, 1 in standby) can be used in most cases. With large plants (> 400 m<sup>3</sup>/hr or 1800 gpm), however, it may be more appropriate to have 3 lines (2 x 50% in parallel, 1 in standby) to reduce system redundancy, optimize flow conditions and reduce vessel sizing. In making a design, it is important to ensure that there is enough time for the standby lines to complete regeneration before they are required to go back on line. The optimum number of lines with minimum redundancy can be calculated using the following formula:

If the equation predicts a non-integer result, the number should be rounded down to obtain the optimum number of lines. For example, a 10 hour run length with a 3 hour regeneration time gives a ratio of 4.3, so the number of lines with minimum redundancy would be 4.

#### 7.5.8. Mixed Bed Design Consideration

A polishing mixed-bed will be required if the product water

#### 7.5.7. Number of Lines

Berdasarkan laju aliran dan *throughput* yang dibutuhkan, jumlah *line* yang beroperasi pada saat yang sama perlu ditentukan. *Layout* paling sederhana dengan 2 *line* (1 dalam operasi, 1 dalam *standby*) dapat digunakan dalam banyak kasus. Dengan kilang yang besar (>400 m<sup>3</sup>/hr atau 1800 gpm), mungkin lebih tepat untuk memiliki 3 *line* (2 x 50% secara paralel, 1 dalam keadaan *standby*) untuk mengurangi redundansi sistem, mengoptimalkan kondisi aliran dan mengurangi *vessel sizing*. Dalam membuat desain, penting untuk memastikan bahwa ada cukup waktu untuk *standby line* untuk menyelesaikan regenerasi sebelum mereka diminta untuk kembali ke *line*. Jumlah optimal *line* dengan redundansi minimum dapat dihitung dengan menggunakan rumus berikut:

Jika persamaan memprediksi hasil non bilangan bulat, angka tersebut harus dibulatkan ke bawah untuk mendapatkan jumlah *line* yang optimal. Misalnya, run length 10 jam dengan waktu regenerasi 3 jam memberikan rasio 4,3, sehingga jumlah baris dengan redundansi minimum adalah 4.

#### 7.5.8. Mixed Bed Design Consideration

Polishing mixed-bed akan diperlukan jika spesifikasi product

specification is below that achievable from the demineralization plant alone or if a higher degree of safety is required to ensure water quality. The mixed bed outlet water should be about 0.10  $\mu\text{S}/\text{cm}$  at 25°C and 0.010 to 0.020 mg/l as  $\text{SiO}_2$  (10 to 20 ppb).

Below are some general guidelines for designing a working mixed bed downstream of a demineralization plant:

- a) Use the latest Ion Exchange Resin Technology which minimize waste generated, minimize chemical and minimize utilities consumption.
- b) Resin volume ratio of cation to anion should be in the range 40:60 to 60:40.
- c) Flow rate 20-40 bed volumes per hour.
- d) Regenerate levels of 80-100 g  $\text{HCl}/\text{L}$  or 120-160 g  $\text{H}_2\text{SO}_4/\text{L}$  cation and 80-100 g  $\text{NaOH}/\text{L}$  anion.
- e) Maximum service run length < 4 weeks.
- f) Maximum silica loading lower than 1.0 g  $\text{SiO}_2/\text{L}$  anion resin at end-of-cycle.
- g) Minimum cation resin bed depth of 450 mm (1.5 feet).

water di bawah yang dapat dicapai dari kilang demineralisasi saja atau jika tingkat keamanan yang lebih tinggi diperlukan untuk memastikan kualitas air. Mixed bed outlet water harus sekitar 0,10 S/cm pada 25°C dan 0,010 hingga 0,020 mg/l sebagai  $\text{SiO}_2$  (10 hingga 20 ppb).

Di bawah ini adalah beberapa panduan umum untuk mendesain working mixed bed downstream di hilir kilang demineralization.

- a) Gunakan Teknologi *Ion Exchange Resin* terbaru yang meminimalkan limbah yang dihasilkan, meminimalkan bahan kimia dan meminimalkan konsumsi utilitas.
- b) Rasio volume resin kation terhadap anion harus dalam kisaran 40:60 to 60:40.
- c) *Flow rate 20-40 bed volumes per jam.*
- d) *Regenerate levels 80-100 g HCl/L atau 120-160 g H<sub>2</sub>SO<sub>4</sub>/L cation dan 80-100 g NaOH /L anion.*
- e) *Maximum service run length < 4 weeks.*
- f) Maximum silica loading lebih rendah dari 1.0 g  $\text{SiO}_2/\text{L}$  anion resin pada *end-of-cycle*.
- g) *Minimum cation resin bed depth 450 mm (1.5 feet).*

## 8. APPENDIX

APPENDIX A - SAMPLE OF PROCESS DATA SHEET DEMINERALIZER PACKAGE (MIX-BED POLISHING

## 8. LAMPIRAN

APPENDIX A - SAMPLE OF PROCESS DATA SHEET DEMINERALIZER PACKAGE (MIX-BED POLISHING

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PACKAGE)

PACKAGE)

**APPENDIX - A**  
**SAMPLE OF PROCESS DATA SHEET DEMINERALIZER PACKAGE**  
**(MIX-BED POLISHING PACKAGE)**

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<b>REFINING DIRECTORATE</b>			SHEET 1 OF 9						
<b>PROCESS DATA SHEET</b>									
<p><b>PROCESS DATA SHEET</b>  <b>MIXBED POLISHING I PACKAGE (A-337-08A/B)</b></p> <p><b>REFINERY DEVELOPMENT MASTER PLAN (RDMP) PROJECT</b>  <b>REFINERY UNIT-V BALIKPAPAN</b></p> <p><b>PT PERTAMINA (PERSERO)</b>  <b>2017, 2018</b></p> <p><b>THIS DOCUMENT SUPERSEDES 26070-203-MWA-337-J0002</b></p>									
B01	9-May-18	RE-ISSUED FOR BID	RB	RK	PD	-	TM	SM	
B00	26-Oct-17	ISSUED FOR BID	PKD	RC	-	-	RC	SM	
00A	23-Feb-17	ISSUED FOR APPROVAL	MF5	MH	EFN	SM	DC	JP	
REV.	DATE	DESCRIPTION	PREP'D	CHK'D	REVW'D	CONCUR	APP'D	ENG MGMT	CLIENT

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**Revision History**

Amendment date	Revision Number	Amender Initials	Sheet Revised	Amendment
23-Feb-17	00A	MF5		
26-Oct-17	B00	PKD	3,4,5	<ul style="list-style-type: none"> <li>- Normal flowrate of Desalinated water updated as per PFD 26070-203-M5-337-J0003 Sh 1 of 3, Rev B02.</li> <li>- Design temperature updated of Desalinated water as per BEDD 26070-203-3BD-G04-J0001 Rev 001.</li> <li>- Note 2 added as reference for Na<sup>+</sup>,Cl<sup>-</sup>,CO<sub>2</sub>, Hardness, and Sodium + Potassium condition for Desalinated and polished water.</li> <li>- Max TOC value updated as per water system package design basis 26070-203-3BD-B04-J0001 Rev B01.</li> <li>- Total iron (as Fe) max value updated for inlet and performance guarantee section.</li> <li>- Conductivity unit updated as per BEDD 26070-203-3BD-G04-J0001 Rev 001.</li> <li>-Unit of Silica (as SiO<sub>2</sub>) quantity updated in performance guarantee section.</li> </ul>
9-May-18	B01	RB	3, 5, 9	Train configuration updated and normal flow rate revised.

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DOCUMENT No. : 26070-203-MXA-337-JA008		REVISION : B01	PAGE: 3 OF 9		NOTE	
AREA	UTILITIES	TAG NO.	A-337-08-A/B			
SITE	REFINERY UNIT V BALIKPAPAN	DESCRIPTION	MIXBED POLISHING I PACKAGE			
UNIT	337 - DEMINERALIZATION SYSTEM	NO. REQ.	1 (ONE) PACKAGE			
		REF. DOC	26070-203-M5-337-J0003 Rev B03			
<b>REQUIREMENTS</b>						
<b>1. GENERAL</b>						
1						
2	Location	: Outdoor, Marine Environment				
3	Area Classification	: By Mechanical				
4	Design Code & Standard	:				
5	Pressure Vessel	: By Mechanical				
6	Pumps / Blowers	: By Mechanical				
7	Electrical & Instrument Equipment	: By Mechanical				
<b>2. PROCESS DESIGN DATA</b>						
9	Description	Basis of Design		Unit	Remarks	
10		Normal	Design			
11	<b>Feed</b>					
12	Desalinated Water	: 752.5 (Note 9)	1,600	m <sup>3</sup> /hr		
13	<b>Product</b>					
14	Polished Desalinated Water	: 752.5 (Note 9)	1,600	m <sup>3</sup> /hr		
15	<b>Feed Water Condition</b>					
16	Pressure	: 4.52	10	kg/cm <sup>2</sup> g		
17	Temperature	: 30	85	°C	Vendor to advise max. temp. which media can withstand while still meets req'd performance	
18	<b>Regeneration Effluent</b>					
19	Pressure	: By Vendor	10	kg/cm <sup>2</sup> g		
20	Temperature	: By Vendor	85	°C		
21	<b>Utility Condition</b>					
22	<b>Instrument Air</b>					
23	Pressure	: 8*	10	kg/cm <sup>2</sup> g	Conditions exist at B/L Unit 335 IA, PA, & N2.	
24	Temperature	: 40	85	°C	Vendor to expect lower arrival pressure	
25						
26						
27						
<b>3. SYSTEM CONFIGURATION</b>						
29	Minimum requirement for equipment of Mixed Bed Polishing Package I consists of (but not limited to) the following :					
30	Item No	Service	No. Required	Remarks (See Note 6)		
31				Package consists of 7 (seven) vessels:		
32	A-337-08A/B	Polisher	1 package	5 operating + 1 regenerating + 1 Standby Vessel(s)		
<b>4. DESIGN CAPACITY</b>						
34	<b>FEED</b>	Desalinated Water	By Vendor	By Vendor	Note 1	
35	Desalinated Water for Regeneration Cycle		By Vendor	By Vendor	Note 1	
36	Demineralized Water for Regeneration Cycle		By Vendor	By Vendor	Note 1	
37	<b>Product</b>		Design : 1600 m <sup>3</sup> /hr	Normal: 752.5 m <sup>3</sup> /hr (Note-9)		

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<b>5. FEED WATER CONDITION</b>						
38	<b>Desalinated Water</b>					
39						
40	Pressure	: Normal : 4.52	kg/cm <sup>2</sup> g			
41	Temperature	: Normal : 30	°C			
42	Total Dissolved Solid (TDS)	: Max. 10	mg/L			
43	pH	: 7.2 to 8.2	mg/L		Note 2	
44	Cu	: < 0.04	mg/L		Note 3	
45	Total Iron (as Fe)	: Max. 0.01	mg/L		Note 3	
46	Mn	: < 0.1	mg/L		Note 3	
47	SiO <sub>2</sub>	: < 0.05	mg/L		Note 2	
48	Conductivity @25°C	: 20	µmho		Note 2	
49	Na <sup>+</sup>	: < 5.0	mg/L		Note 2	
50	Cl <sup>-</sup>	: < 5.0	mg/L		Note 2	
51	TOC	Normal : 0.1 Max : 0.1	mg/L			
52	CO <sub>2</sub>	: < 5	mg/L		Note 2	
<b>6. OUTLET WATER CONDITION</b>						
53	<b>Polished Water</b>					
54						
55	General Requirement	: Clear & Colorless				
56	Hardness	: Zero			Note 2	
57	Total iron (as Fe)	: Max. 0.01	mg/L		Note 3	
58	Cl <sup>-</sup>	: Max. 0.01	mg/L		Note 3	
59	Total Copper & Nickel (as Cu)	: Max. 0.003	mg/L		Note 3	
60	Conductivity (@25 °C)	: Max. 0.5	µmho		Note 2	
61	pH	: 5.5 to 7			Note 2	
62	Silica	: Max. 0.02	mg/L		Note 2	
63	Sodium + Potassium	: < 0.01	mg/L		Note 2	
64	Pressure Drop	: Normal : 0.5 - 1.0	kg/cm <sup>2</sup>		Note 5	
65	<b>Regeneration Effluent</b>					
66	pH	: By Vendor				
67	Pressure	: By Vendor	kg/cm <sup>2</sup> g			
68	Temperature	: By Vendor	°C			
<b>7. CHEMICALS</b>						
69						
70	Cation Resin	: By Vendor	m <sup>3</sup>	Strong Acid Cation (SAC)	Note 1	
71	Anion Resin	: By Vendor	m <sup>3</sup>	Strong Base Anion (SBA)	Note 1	
72	Acid Regenerant	: By Vendor	kg	H <sub>2</sub> SO <sub>4</sub>	Note 1	
73	Base Regenerant	: By Vendor	kg	NaOH	Note 1	
<b>8. UTILITY CONDITION</b>						
72						
73	<b>Instrument Air</b>					
74	Pressure	: Normal : 8	kg/cm <sup>2</sup> g			
75	Temperature	: Normal : 40	°C			
76	Dew Point	: Normal : minus 40	°C			
77	<b>Electric Power Supply</b>					
78	Motors, Larger than 150 kW	: 6600 V, 3-phase, 50 Hz				
79	Motors, 0.37 kW to 150 kW	: 380 V, 3-phase, 50 Hz				
80	Motors, 0.37 kW & below	: 220 V, 1-phase, 50 Hz				
81	<b>Desalinated Water (for backwash &amp; rinsing)</b>					
82	Pressure	: Normal : 4.52	kg/cm <sup>2</sup> g			
83	Temperature	: Normal : 30	oC			
84	<b>Demin Water (for regeneration cycle)</b>					
85	Pressure	: Normal : 30	kg/cm <sup>2</sup> g		Available at 450 m <sup>3</sup> /hr	
86	Temperature	: Normal : 50	oC			

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87	<b>9. UTILITY CONSUMPTION</b>				
88	Desalinated Water (for Backwash) :	30	m <sup>3</sup> /vessel/regeneration	Note 4	
89	Demineralized Water :	185	m <sup>3</sup> /vessel/regeneration	Note 4	
90	Instrument Air :	By Vendor		Note 1	
91	Electric Power :	By Vendor		Note 1	
92	<b>10. PERFORMANCE GUARANTEE</b>				
93	<b>Production</b> :				
94	Polished Water Production (design per train) :	320	m <sup>3</sup> /hour/vessel	Note 6	
95	Service Time :	Min. 24	hour/vessel		
96	<b>Polished Water Quality</b>				
97	General Requirement :	Clear & Colorless			
98	Hardness :	Zero			
99	Total Iron (as Fe) :	Max. 0.01	mg/L		
100	Cl- :	Max. 0.01	mg/L		
101	Total Copper + Nickel (as Cu) :	Max. 0.003	mg/L		
102	Silica (as SiO <sub>2</sub> ) :	Max. 0.02	mg/L		
103	Conductivity (@25 oC) :	0.5	µmho		
104	pH :	5.5 to 7			
105	Sodium + Potassium :	0.01	mg/L		
106	Pressure Drop :	Nor. 0.5 - 1.0	kg/cm <sup>2</sup>	Note 5	
107	<b>Chemical &amp; Utility Consumption</b>				
108	Acid Regenerant Consumption :	By Vendor	kg/regeneration		
109	Base Regenerant Consumption :	By Vendor	kg/regeneration		
110	Ion Exchange Resin Life Time :	Min. 5	years		
111	Desalinated Water Consumption :	By Vendor	m <sup>3</sup> /regeneration		
112	Demineralized Water Consumption :	By Vendor	m <sup>3</sup> /regeneration		
113	Instrument Air :	By Vendor	Nm <sup>3</sup> /regeneration		
114	Electric Power :	By Vendor	kWh		
115					
116	<b>11. MECHANICAL EQUIPMENT DESIGN</b>				
117	<b>11.1 POLISHER VESSELS</b>				
118	No. Required.:				Solid Type
119	Fluid Name:				Particle Retention Rating :
120	Specific Gravity:				- Normal Operation micron
121	Viscosity:	cP			- Start Up Operation micron
122	Capacity:	m <sup>3</sup>			Filtration Efficiency %
123	Design Internal Press. :	kg/cm <sup>2</sup> @	° C:	Special Service	<input type="radio"/> Yes <input type="radio"/> No
124	Design External Press. :	kg/cm <sup>2</sup> g	° C:	Cyclic Service	<input type="radio"/> Yes <input type="radio"/> No
125	MAWP:	kg/cm <sup>2</sup> g	° C:	Fluid Retention Time :	minute
126	Max. Allowable External Pressure :	kg/cm <sup>2</sup> g	Allowable Pressure Drop		
127	Minimum Design Metal Temperature:	°C			- Clean kg/cm <sup>2</sup>
128	Oper. Pressure :	kg/cm <sup>2</sup> g			- Dirty kg/cm <sup>2</sup>
129	Oper. Temperature :	°C			Filter Type <input type="radio"/> Catridge <input type="radio"/> Basket <input type="radio"/> Ion Exchange Base
130	Inside Diameter (ID):	mm	Number of Filter Element / Carbon Active		
131	Shell Length (TL-TL):	mm			
132	Test Press. Hydrostatic/Pneumatic:	kg/cm <sup>2</sup>			
133	Surface Preparation & Painting:				
134	Code:	<input type="radio"/> Yes <input type="radio"/> No			
135	Stamping Required:	<input type="radio"/> Yes <input type="radio"/> No			
136	N.B. Registration:	<input type="radio"/> Yes <input type="radio"/> No			
137	Local Regulating Authority :	<input type="radio"/> Yes, Migas Certificate <input type="radio"/> No			
138	ASME Authorized Inspection Agency	<input type="radio"/> Yes <input type="radio"/> No			
139	Fatigue Analysis Required:	<input type="radio"/> Yes <input type="radio"/> No			
140	Corrosion Allow. (mm)	Heads-Shell:	Nozzles:	Internals:	

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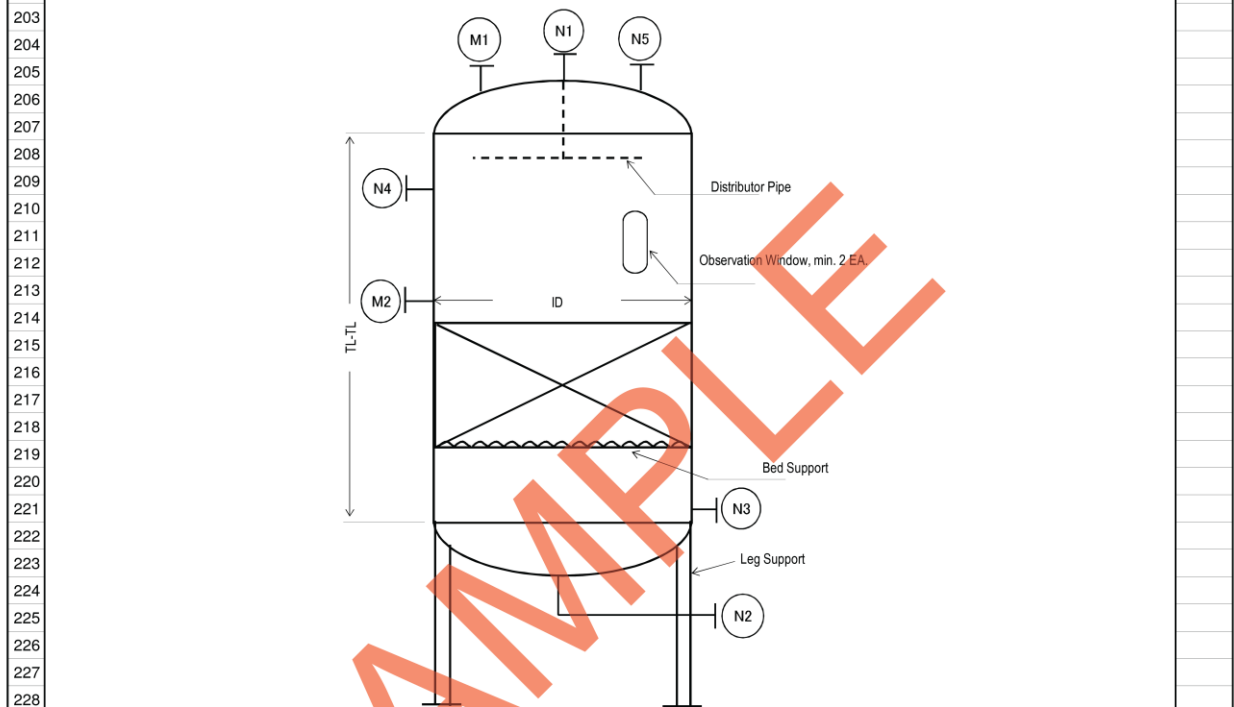


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Vessel Connections							
No	Size	Schedule	Rating	Flange	Projection (mm)	Service	
196	N1		By Vendor			Inlet	
197	N2		By Vendor			Outlet	
198	N3		By Vendor			Outlet (Resin)	
199	N4		By Vendor			Inlet (Regent)	
200	N5		By Vendor			Vent	
201	M1/M2		By Vendor			Manhole	

202 Vessel Sketch (Typical. Vendor to Finalize)



229 11.2 AIR BLOWERS		Location		<input type="radio"/> Outdoor	<input type="radio"/> Indoor
230 No. Required:		Manufacturer	By Vendor		
231 Service :		Model No.	By Vendor		
232 Code / Standard:		Driver	<input type="radio"/> Motor	<input type="radio"/>	
233 Duty:		Mounted By	<input type="radio"/> Fan /Blower Mfg.	<input type="radio"/>	
234		<b>Operating Conditions</b>		<b>Capacity Control</b>	
235	Gas Handled:	Suction Condition	Press. By Vendor kg/cm <sup>2</sup> G	Method :	
236	Composition:	Discharge Condition	Temp. By Vendor °C	<input type="radio"/> Inlet Vane	
237	Molecular Weight:		Press. By Vendor kg/cm <sup>2</sup> G	<input type="radio"/> Suction Damper	
238	Ratio of Specific Heat:		Temp. By Vendor	<input type="radio"/> Discharge Damper	
239	Relative Humidity @ Operate Temp. (%)	Actual Speed	By Vendor	<input type="radio"/> Speed Variation	
240	Gas Flow @ 0°C 1 ATM. (Nm <sup>3</sup> /h)	Rated Efficiency	By Vendor	Actuation:	
241	@ Suction Condition (m <sup>3</sup> /h)	Rated BHP	By Vendor	<input type="radio"/> Auto <input type="radio"/> Manual <input type="radio"/> Hand	
242	In Weight Flow (kg/h)	<input type="radio"/> Head - Capacity Curve Continuous Rising			
243	<b>Construction Features</b>		<b>Inspection and Test</b>		
244	Blower Type:	<input type="radio"/> Centrifugal <input type="radio"/> Axial <input type="radio"/> Rotary	Shop Inspection <input type="radio"/> Req'd <input type="radio"/> Witness		
245	Rotor Type:		Hydrostatic <input type="radio"/> Req'd <input type="radio"/> Witness		
246	No. of Stage:		Running Test <input type="radio"/> Req'd <input type="radio"/> Witness		
247	Rotation Viewed from Driver	<input type="radio"/> C.W. <input type="radio"/> C.C.W.	Performance <input type="radio"/> Req'd <input type="radio"/> Witness		
248	Nozzles	Size Rating Facing Location	Dissassembly <input type="radio"/> Req'd <input type="radio"/> Witness		
249	Suction	By Vendor	Dynamic Balance <input type="radio"/> Req'd <input type="radio"/> Witness		
250	Discharge	By Vendor	Field Test <input type="radio"/> Req'd <input type="radio"/> Witness		
251			Hydrotest Pressure (kg/cm <sup>2</sup> G)		
252			Pneumatic Test Press. (kg/cm <sup>2</sup> G)		
253			Sound Level @ 1 meter (dB)		
254					

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255 Casing:				<b>MOTOR DATA</b>		
256 Split	<input type="radio"/> Horizontal <input type="radio"/> Vertical	By Vendor		Power (Volt/Ph/Hz) : 380 V / 3 Ph / 50 Hz		
257 Design	Pressure _____	kg/cm2g		Manufacturer : By Vendor		
258	Temperature _____	°C		Model No. : By Vendor		
259 Connections	<input type="radio"/> Drain <input type="radio"/>			Enclosure :		
260 Rotor:					Protection :	
261 Diameter (mm)	_____				Insulation :	
262 Tip Speed (m/s)	_____				Temp. Rise (°C) :	
263 Max. Allow Tip Speed (m/s)	_____				Output (kW) :	
264 Critical Speed	_____				Speed (rpm) :	
265 Inertia @ Shaft End (kg-m <sup>2</sup> )	_____				Electrical Class. :	
266 Bearing :					<b>ACCESSORIES</b>	
267 Type :	Radial :	_____		<input type="checkbox"/> Suction Filter		
268	Thrust :	_____		<input type="checkbox"/> Suction Silencer		
269 Lubrication:					<input type="checkbox"/> Discharge Silencer	
270 Drive: By Vendor					<input type="checkbox"/> Acoustic Enclosure	
271 <input type="radio"/> Direct <input type="radio"/> Gear <input type="radio"/> V-Belt					<input type="checkbox"/> Oil Pump Unit (incl. piping and inst.)	
272 Speed Ratio _____					<input type="checkbox"/> Flexible Joint (for suction & discharge)	
273 Coupling or V-Belt					<b>LOADING DATA</b>	
274 Type : _____ <input type="radio"/> With Guard					Weight (kg)	
275 Mfg : _____					Blower _____	
276 Driver Half Mounted By :					Driver _____	
277 <input type="radio"/> Fan / Blower MFG. <input type="radio"/>					Lube Oil Unit _____	
278 Baseplate:					Baseplate _____	
279 <input type="radio"/> Common, with <input type="radio"/> Gear <input type="radio"/> Driver					Acoustic Enclosure _____	
280 <input type="radio"/> Fan and Blower only					Total _____	
281 <input type="radio"/> Drain Rim					Space L x W x H, mm _____	
282 <input type="radio"/> Fabricated Steel						
283 Shaft Seal:						
284 Type:						
285						
<b>Material for Blower</b>						
286 Casing:	<input type="radio"/> Cast Iron	<input type="radio"/> Carbon Steel	<input type="radio"/> Stainless Steel			
287 Rotor	<input type="radio"/> Cast Iron	<input type="radio"/> Carbon Steel	<input type="radio"/> Stainless Steel			
288 Shaft	<input type="radio"/> Carbon Steel	<input type="radio"/> Stainless Steel				
289 Shaft Sleeves	<input type="radio"/> By Vendor					
290 Bearing Housing	<input type="radio"/> By Vendor					
291 Case Studs	<input type="radio"/> By Vendor					
292 Case Gasket	<input type="radio"/> By Vendor					
<b>12. CONTROL SYSTEM</b>						
293						
294 Location Control Panel	: Outdoor					
295 Control System	: PLC					
296 Instrumentations	: Conductivity Meter, Silica Analyzer, pH meter, etc.					
297 Supervisory Instrumentations	: Conductivity meter, pH meter, Flow Indicator, Trip for Blower, Common Alarm, Indication Light, etc.					
298	Polisher package control system shall consists of Local Control panel with PLC, controller, indications, push buttons, etc.					
299	Normal operation of the package will be conducted through Local Control Panel & PLC.					
300	PLC shall communicate with Purchaser's BPCS / DCS for Supervision and monitoring of Package system.					
301						
<b>13. PIPING MATERIALS</b>						
302 Acid Regeneration Line	: By Mechanical					
303 Caustic Regeneration Line	: By Mechanical					
304 Inlet Polisher I Package	: By Mechanical					
305 Outlet Polisher I Package	: By Mechanical					
306 Inlet Polisher II Package	: By Mechanical					
307 Outlet Polisher II Package	: By Mechanical					
308 Inlet Polisher III Package	: By Mechanical					
309 Outlet Polisher III Package	: By Mechanical					
310 Drain to Neutralization Pit	: By Mechanical					
311						
<b>14. STRUCTURE MATERIALS</b>						
312 Skid Structures	: By Mechanical					
313 Pipe Supports or Pipe Racks	: By Mechanical					
314						

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<b>15. NOTES</b>					
315					
316	1	To be determined by Vendor. Vendor shall optimize Total Life Cycle cost by choosing the adequate resin type which minimize waste generated and minimize chemical and utilities consumption. Owner prefer to use latest Ion Exchange Resin technology.			
318	2	Refer to 26070-203-3BD-B04-J0001_Design Basis Water System Package.			
319	3	Typical specification. Vendor to suggest.			
320	4	Preliminary calculation. To be finalized by Vendor.			
321	5	Typical. Vendor shall ensure that pressure drop across desalinated water polishing system is < 1.5 kg/cm2 (including line loss)			
322	6	Vendor shall optimize no of operating vessel to ensure good hydraulic as per vendor expertise and experience. Vendor shall provide at least 1 vessel for standby and 1 vessel for regeneration.			
324	7	The Operation and regeneration of the package shall be fully automatic with provision for manual operation when desired.			
325	8	Acid/Base Injection at Regeneration Cycle may use Demineralized Water while for rinsing step may use Desalinated Water. Vendor to advise			
327	9	As per Overall Utility Summary, Rev B04 (Doc no. 26070-203-M4-300-J0001), capacity required for design case and rating case are 1309 m3/hr and 1471.6 m3/hr respectively for phase II operation.			
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