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**TN 279478**

**Description Revision**

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Page 1 of 26

**Revision:**

02

# European tender specification document for Crystallizer equipment & drying equipment combined with a silo

Requested by

Elemetal B.V.

February 2021

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# 1. Introduction

## 1.1 Information contracting entity

### Delivery address:

PlantOne – Elemetal B.V.  
Merseyweg 10  
3197 KG Botlek-Rotterdam  
Netherlands

### Invoice address:

Elemetal B.V.  
Watermanweg 106a  
3067 GG Rotterdam  
Netherlands

CC: 27352751

VAT nr.: 821192620B01

LIFE project code: LIFE14 ENV/NL/000029 - LIFE PCR

**Tender number: TN 279478**

## 1.2 Contact information

All communication regarding this tender proceeds preferably by email with:

W. (Wout) Lohle

Email: [wlohle@elemetal.eu](mailto:wlohle@elemetal.eu)

Phone: +31 6 48 517 237

Adres: Merseyweg 10, 3195KG Botlek-Rotterdam, Netherlands

## 1.3 General information Elemetal B.V.

Elemetal B.V. was founded in August 2009, with a focus on up-cycling of non-ferrous metals from secondary/waste streams. Today, we have built an expertise in separating difficult waste streams through hydrometallurgical and physical separation processes and have several granted patents. Your inseparable stream is our challenge!

We consist of highly motivated people with a background in chemical engineering, mining, mechanical and process engineering to provide a custom solution for the requirements of each customer.

This tender contains different lots for the commissioning of a demonstration plant. The mission statement of this tender is to get functioning crystallization equipment and drying equipment combined with a silo delivered turn-key in place.

## 2. Tender description

For completion of the demonstration plant Elemetal B.V., from now called 'contracting entity', request the build, delivery, and commissioning of several parts of the demonstration plant. In this document the entity submitting the bid is called 'tenderer'. The contracting entity has chosen to divide this tender into the two following lots:

1. Mixing reactor (excluded from tender)
2. Crystallizing equipment
3. Drying equipment combined with a silo
4. 2 x filter press (excluded from tender)

Further details and specifications can be found in Chapter 0, 5 & 6. The contracting entity has the aim to have the equipment build and commissioned as soon as possible. The announcement mentioned 4 lots. However, lot 1 and 4 are excluded from this tender.

### 2.1 Scope

The project is a demonstration project where it is important to keep the investment low. The goal of the project is to demonstrate the production of the zinc sulfate monohydrate crystal and to validate this into the market.

#### 2.1.1 Lot 1: mixing reactor (excluded from tender)

The mixing reactor lot is excluded from this tender.

#### 2.1.2 Lot 2: crystallizing equipment

This lot concerns a quotation for a crystallization system to produce Zinc sulfate monohydrate crystals from a zinc sulphate solution. More details on the scope of supply and battery limits are described in Chapter 5. The system should be delivered as a turnkey subsystem of the full Elemetal demonstration plant which can easily be integrated in the overall process. This lot includes the delivery of the equipment to the delivery address.

#### 2.1.3 Lot 3: drying equipment in combination with a silo

This lot concerns a quotation for a dryer to dry zinc sulfate monohydrate crystals from a crystallizer/centrifuge combination. The dried product is required to be transported into a silo. More details on the scope of supply and battery limits are described in Chapter 6. The system should be delivered as a turnkey subsystem of the full Elemetal demonstration plant which can easily be integrated in the overall process. This lot includes the delivery of the equipment to the delivery address.

#### 2.1.4 Lot 4: 2 x filter press (excluded from tender)

The filter presses are excluded from this tender.

## 3. Tender procedure

### 3.1 Subscribing and digital tendering

The publication and submission of bids are done on TenderNed and Tenders Electronic Daily (TED). These are online digital platform for European tenders. Tenderers need to have a subscription to TenderNed or TED. In some cases, it can take some weeks before your account is active.

More information can be found on:

<https://www.tenderned.nl/cms/english/submitting-tender-open-procedure>

Tender specification contains confidential information. It is not allowed to use this information in any other way besides for an application.

### 3.2 Planning

A general planning from this tender is listed in Table 1. Note: this is a general outline set in this document as indication for this tender. No rights can be derived from it.

Table 1 Tender planning

| Item                                                 | Planned for      |
|------------------------------------------------------|------------------|
| Publishing tender announcement                       | 08/09/2020       |
| Publishing tender specification                      | 31/10/2020       |
| Final request for documentation                      | 15/03/2020 17:00 |
| Final receival of questions                          | 10/03/2020 23:59 |
| Communicating Note of information                    | 08/03/2020       |
| Final receival of subscription                       | 15/03/2020 17:00 |
| Opening of the vault                                 | 15/03/2020 17:00 |
| Sending assessment of subscriptions and award result | 25/03/2020       |
| Sending awarded contract                             | 30/03/2021       |
| Publishing announcement of awarded contract          | 30/04/2021       |

As mentioned in Table 1 tenderers are given the opportunity to ask questions by submitting a filled-out 'Attachment B. Question form'. All questions will be answered and all tenderers who requested documentation receive a communicating note of information containing answers (where possible) or comments to all the questions submitted. The tenderers have a deadline for a final receival of subscription by the contracting entity. After this deadline, the contracting entity will receive all the subscriptions from the vault and internally assesses the subscription. After the assessment, a letter will be sent to all tenderers with their score and award result. After informing all tenderers of the award results one contracting entity (per lot) will receive an awarded contract. After the contract is awarded an announcement on this will be published.

### 3.3 Declaration of conduct

If you have won a contract, the commissioning authority can ask you for a Declaration of conduct for tenderers (Gedragsverklaring aanbesteden, GVA). You can obtain a GVA (in Dutch) from judiciary service Justis (Ministry of Justice and Security). It is recommended to request this declaration beforehand.

### 3.4 Lodging an objection against the result

If you disagree with the outcome of the tender procedure, you have 20 calendar days to lodge an objection against the intention to award. If this is the case, the tenderer is requested to send an email to [wlohle@elemetal.eu](mailto:wlohle@elemetal.eu) with the title Objection – Demonstration plant Elemetal B.V. – ‘company name tenderer’. This email must contain motivated and structured specification on subjects where the tenderer does not agree with the contract award.

More information on objection can be found with the following link:  
<https://business.gov.nl/regulation/submitting-tenders/>

### 3.5 Exceptions and deviations

All equipment within the scope of supply shall be designed, engineered, manufactured, inspected, tested and delivered as much as possible conform with this specification. It is however understood by both parties that the project is part of a process under development and scope might change during the project. Any deviations from this specification by one of the parties shall be stated clearly and clarified and agreed upon. To keep track of these changes or deviations a change log is created. The change log is periodically communicated between the contracting entity and tenderer to prevent miscommunications. Contact information for communication after contract awards are listed in Table 2.

Table 2 Contact information for specific communications

| Question type                  |                 | Phone         | E-mail               |
|--------------------------------|-----------------|---------------|----------------------|
| General questions              | Bert-Jan Kuiper | +31 683631845 | Bkuipers@elemetal.eu |
| Change communication           | Bert-Jan Kuiper | +31 683631845 | Bkuipers@elemetal.eu |
| Technical mechanical questions | Wout Lohle      | +31 648517237 | wlohle@elemetal.eu   |

## 4. Grounds for disqualification

### 4.1 Requirements

The tenderer is obliged to meet all the requirements set in this document. In addition, the tenderer is obliged to meet the conditions set in '*Attachment A. Purchase conditions Elemetal B.V.(Inashco)*'. Failure to comply with one or more requirements from this chapter will automatically lead to disqualification of the contracting entity. Detailed specifications and requirements regarding deliverables and equipment are listed in Chapter 0 & □ for lot 2 and lot 3, respectively.

As mentioned, the tenderer must comply to all requirements. If contradictions or ambiguities in the design requirements or required documents are noticed, the tenderer must ask questions about this in the question round by means of '*Attachment B. Question form*'



## 5. Requirements Lot 2: Crystallization equipment

This chapter contains all information about the tender document deliverables, design specifications and requirements for Lot 2: Crystallization equipment.

### 5.1 Tender document deliverables

A complete subscription to Lot 2 must include the following documents:

1. Subscription form ('Attachment C. Subscription form tenderer')
2. Uniform Europees aanbestedingsdocument (Document in tender folder)
3. Quotation
4. Reference projects
5. Time schedule
6. Technical data
7. Service and Maintenance schedule

More information regarding the requirements for these documents is provided in the next sections.

#### 5.1.1 Subscription form

The tenderer must deliver a filled-out, duly signed copy of 'attachment C. Subscription form tenderer' in a .pdf format for this lot.

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Attachment C. Subscription form tenderer - 'company name'*

#### 5.1.2 Uniform Europees aanbestedingsdocument

The tenderer must deliver a filled-out, duly signed Uniform Europees aanbestedingsdocument in a .pdf format for this lot. Unfortunately, it is not possible to create this document in English.

The file can be found in the tender documents under the name: 'uea\_279478\_20201016135757.pdf'

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *uea\_279478\_20201016135757 - 'company name'*

### 5.1.3 Quotation

The submitted quotation includes all requirements set in this document. This quotation is built up by specifying the following elements:

- Engineering costs
- Equipment costs
  - Specification of main items
- Transport and installation costs

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Quotation lot 2 - 'company name'*

### 5.1.4 Reference projects

To guarantee the technical competence of the tenderer, the contracting entity requires tenderers to show references that the tenderer has the necessary competences regarding this lot for which the tenderer has registered. The tenderer must deliver a reference project document with the subscription to show their references. References are indicated by means of two or more assignments carried out in the past ten years. The previous assignments do not exactly have to match the requirements set in this document but do need to give an indication that the tenderer has the competence to realize this lot. Of course, a very comparable and relevant reference project will have a positive effect on the awarded score. The document reference project must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Reference projects lot 2 - 'company name'*
- Maximum of 4 a4.
- Include a minimum of 2 projects

### 5.1.5 Time schedule

The tenderer must deliver a time schedule showing least the following items:

- Detailed Design / Engineering phase (Elemetal will provide a basic design and concept)
- Quality Control (QC) reviews on design (design/engineering phase)
- QC approval for construction (end of (component) design/engineering phase) – milestone(s)
- Construction phase (this phase can be split up per component)
- Orders and Deliveries of material – milestones
- QC approval for painting – milestone(s)
- QC approval for assembly (check on paint) – milestone(s)
- QC review on documentation 3.2
- Assembly phase
- FAT;
- Approval on FAT – milestone
- Delivery of crystallizer system – milestone
- QC (final) review on documentation
- **Total delivery time (delivered at place)**
- Payment schedule

The time schedule document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Time schedule lot 2 - 'company name'*

### 5.1.6 Technical data

A tender subscription requires a comprehensive description of their scope of supply, including technical specifications with relevant technical, required utilities (steam, power, plant air, cooling water, etc.) and performance data, to enable a proper evaluation. **Specifically note the steam/energy consumption per kilogram of water evaporation in this file.** The design and its according documentation will be made according to the Machinery Directive 2006/42/EC.

The technical data document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Technical data lot 2- 'company name'*

### 5.1.7 Service and maintenance schedule

A tender subscription requires a description of the expected maintenance activities including a schedule of regular inspections. List of initial spare parts and consumables. This document must also include an hour unit rates for work provided at site.

The service and maintenance schedule document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Service and maintenance schedule lot 2 - 'company name'*

### 5.1.8 Warranty

A tender subscription requires a document description of the warranty given by the tenderer. Mention and clearly describe the warranties and the associated conditions. E.g. when wear parts are mentioned, the specific wear parts need to be fully mentioned; reference must be made to a proper instruction for cleaning and maintenance; etc. With respect to corrosion of metal equipment a warranty of at least 18 months is asked for.

The warranty document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *warranty document lot 2 - 'company name'*

## 5.2 Process information

Before listing technical design specifications some additional information about the process is provided in this section.

### 5.2.1 Input Material

The solution which will be fed to the crystallizer system has typically the following composition.

Table 3 Typical input composition of liquid into crystallizer

| Al<br>(ppm) | Ca<br>(ppm) | Co<br>(ppm) | Cr<br>(ppm) | Cu<br>(ppm)              | Fe<br>(ppm)             | K<br>(ppm)  | Mg<br>(ppm) | Mn<br>(ppm) | Na<br>(ppm) |
|-------------|-------------|-------------|-------------|--------------------------|-------------------------|-------------|-------------|-------------|-------------|
| 200         | 393         | 1           | 6           | 13                       | 150                     | 10          | 70          | 15          | 159         |
| Ni<br>(ppm) | Pb<br>(ppm) | Zn<br>(g/l) | Cl<br>(ppm) | PO <sub>4</sub><br>(ppm) | SO <sub>4</sub><br>[m%] | Si<br>(ppm) | Sn<br>(ppm) | Ti<br>(ppm) |             |
| 15          | 14          | 161.14      | 733         | 43                       | 222.74                  | 108         | 2           | 6           |             |

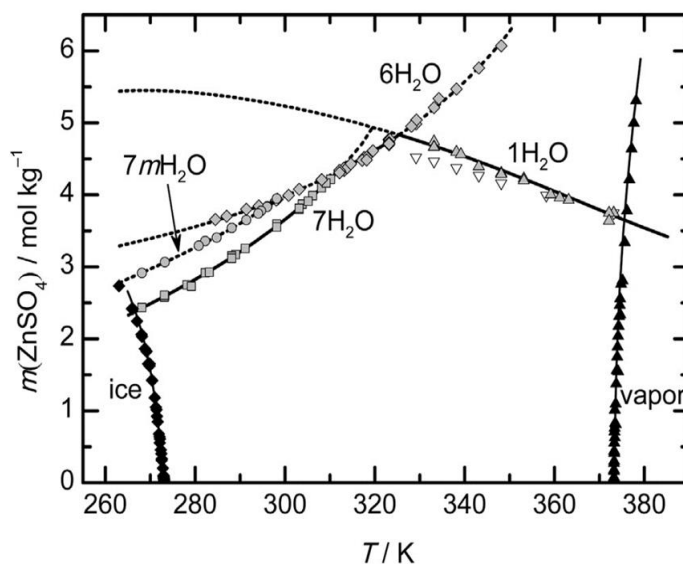
Furthermore, the conditions listed in 4.

Table 4 Process condition input crystallizer

| Inputs                         | Value                 |
|--------------------------------|-----------------------|
| Design flow rate input         | 1,3 m <sup>3</sup> /h |
| Density                        | 1,3-1,45 kg/l         |
| Temperature                    | >50°C                 |
| Pressure                       | Ambient               |
| Dynamic Viscosity $\mu$ (20°C) | 0,0125 kg/(m*s)       |
| Dynamic Viscosity $\mu$ (80°C) | 0,0065 kg/(m*s)       |

### 5.2.2 Product

The phase diagram for zinc sulphate is shown Figure 1. The desired product is zinc sulphate monohydrate ( $\text{ZnSO}_4 \cdot \text{H}_2\text{O}$ ). This crystal can be formed by oversaturation of the liquid 330 K. This means that we will need an evaporative crystallization process to form monohydrates. Table 5 gives useful values involved regarding these solutions shown in Figure 1.

Figure 1 Phase diagram for  $\text{ZnSO}_4$ 

(source: <https://www.sciencedirect.com/science/article/abs/pii/S0021961417303300>)

Table 5 Values for ZnSO<sub>4</sub>-solutions

| ZnSO <sub>4</sub><br>(mol/kg) | ZnSO <sub>4</sub><br>kg/kg liquid | Wt. % | Zn<br>kg/kg liquid | Density<br>(kg/l) | ZnSO <sub>4</sub><br>kg/l | Zn<br>(kg/l) |
|-------------------------------|-----------------------------------|-------|--------------------|-------------------|---------------------------|--------------|
| 1                             | 163.38                            | 16%   | 65.38              | 1.17              | 191.1546                  | 76.5         |
| 2                             | 326.76                            | 33%   | 130.76             | 1.31              | 428.0556                  | 171,3        |

### 5.2.3 Expected composition Mother Liquor

In case now extra purge of mother liquor is applied only mother liquor is lost through the moisture in the crystals leaving the centrifuge. The crystals are expected to contain ~5% of mother liquor after centrifuging. Table 6 Expected composition of mother liquor indicates the maximum level of impurities that will build up in the system if only a purge of mother liquor is realized in the crystals. An extra purge of 25-50 l/h can lower this amount by a factor 2 or 3.

Table 6 Expected composition of mother liquor

| Al<br>(ppm) | Ca<br>(ppm) | Cd<br>(ppm) | Co<br>(ppm) | Cr<br>(ppm) | Cu<br>(ppm)              | Fe<br>(ppm)             | K<br>(ppm)  | Mg<br>(ppm) | Mn<br>(ppm) | Na<br>(ppm) |
|-------------|-------------|-------------|-------------|-------------|--------------------------|-------------------------|-------------|-------------|-------------|-------------|
| 5200        | 20436       | 4108        | 52          | 312         | 676                      | 7800                    | 520         | 3640        | 520         | 8268        |
| Ni<br>(ppm) | Pb<br>(ppm) | Sr<br>(ppm) | Zn<br>(g/l) | Cl<br>(ppm) | PO <sub>4</sub><br>(ppm) | SO <sub>4</sub><br>[m%] | Si<br>(ppm) | Sn<br>(ppm) | Ti<br>(ppm) |             |
| 780         | 728         | 0           | >240        | 38116       | 2236                     | 331.7463                | 5616        | 104         | 312         |             |

### 5.2.4 Proposed Technology

The technology Elemetal would like to implement is a conventional forced circulation crystallizer (FCC) based on evaporation. The system can be built in a single effect configuration or a multiple effect evaporation. Elemetal would like to evaluate the following option:

- Single effect FC crystallizer

### 5.2.5 General flow sheet, battery limits, mass balance and process description

An general indicative flow sheet shown in applies to our system. A flow of ZnSO<sub>4</sub>-solution is fed at a flow rate of ~1,57 ton/h (1,3 m<sup>3</sup>/h) and a temperature >50°C. The slurry containing the ZnSO<sub>4</sub>·H<sub>2</sub>O crystals coming from the system should contain >40% solids to obtain an effective operation of the centrifuge. Therefore, a thickener or hydro-cyclone might be necessary to obtain a >40 m% slurry. The centrifuge is delivered by Elemetal. A more detailed proposed flow sheet for a single effect forced circulating crystallizer is shown in Figure 5.

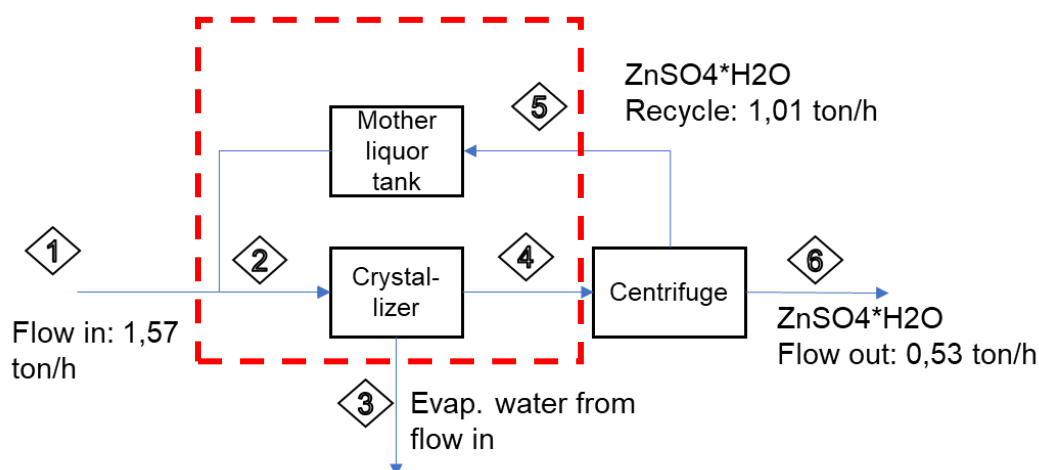


Figure 2 General flow sheet and battery limits (between red dotted line)

Table 7 **Error! Reference source not found.** contains a general mass balance of the crystallizer system within the red block in Figure 2. About ~500 kg/h of solids are produced from the system. An evaporation capacity of 1000 kg/h should be guaranteed.

Table 7 Expected mass balance for flows from Figure 2

| Flow <>                     | 1    | 2      | 3    | 4    | 5      | 6    |
|-----------------------------|------|--------|------|------|--------|------|
| Total flow (kg/h)           | 1,57 | 2,58   | 1,04 | 1,54 | 1,01   | 0,53 |
| X <sub>Zn</sub>             | 0,12 | -      | -    | -    | 0,24   | 0,35 |
| X <sub>SO<sub>4</sub></sub> | 0,17 | -      | -    | -    | 0,36   | 0,52 |
| X <sub>H<sub>2</sub>O</sub> | 0,71 | -      | 1    | -    | 0,4    | 0,13 |
| % Solids                    | N.A. | t.b.d. | N.A. | 32%  | t.b.d. | 95%  |

### 5.2.6 Material selection

Since the system is running at boiling temperatures and chlorides build up in the system, the choice of material is critical. The chlorides are expected to buildup in the system because of the recycle of the mother liquor to the system. It is expected that the chlorides will reach a certain level (see Expected composition Mother Liquor in Table 6) at which it will also co-precipitate with the ZnSO<sub>4</sub>·H<sub>2</sub>O crystals and end up in the product. It is advised to operate the system under vacuum to lower the boiling point.

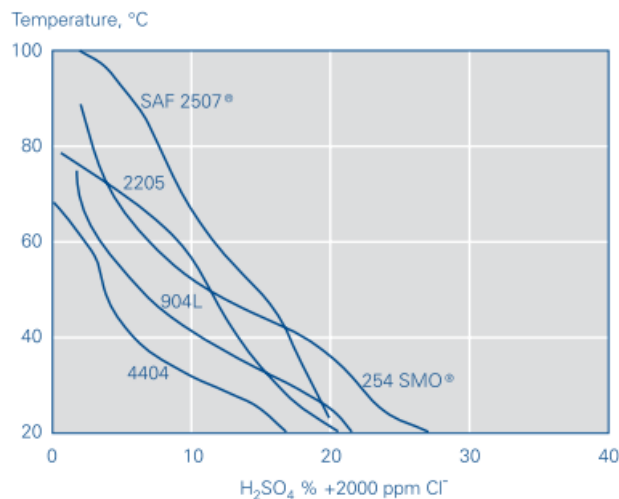


Figure 3 Isocorrosion curves, 0,1 mm/year, in  $H_2SO_4$  containing 2000 ppm chloride ions (source: <http://outokumpu-armetal.com/index.php?id=18>)

The amount of  $H_2SO_4$  in the system at a pH >4,5 is relatively small (<0,001%). Figure 3Figure 2 shows that super duplex (SAF 2507) corrodes less than 0.1mm/year at boiling temperatures with chloride levels of 2000 ppm.

However, it is expected chloride levels will build up far above 2000 ppm which makes super duplex steels questionable. In the operated environment super duplex is expected to hold for the piping. Another option for piping would be a high-grade Glass Fiber Reinforced Plastic (GFRP). The heat exchanger equipment should however be designed from different material. A metal which gives good resistance to high chloride levels is titanium. Figure 4 shows the isocorrosion curves for 3 types of titanium. Titanium grade 2 gives already significant corrosion at 0,5% of  $H_2SO_4$  at boiling temperatures. Grade 12 has useful resistance up to 1% of  $H_2SO_4$  at boiling temperatures. Inhibitors like  $Fe^{3+}$  or  $CuSO_4$  have a positive effect so it might be that  $ZnSO_4$  has a positive effect as well. However, it is expected Grade 2 should be satisfactory at pH > 4,5. Another metal which will hold is Hastelloy C273 which can be used for the tubes side of the heat exchanger and circulation pump.

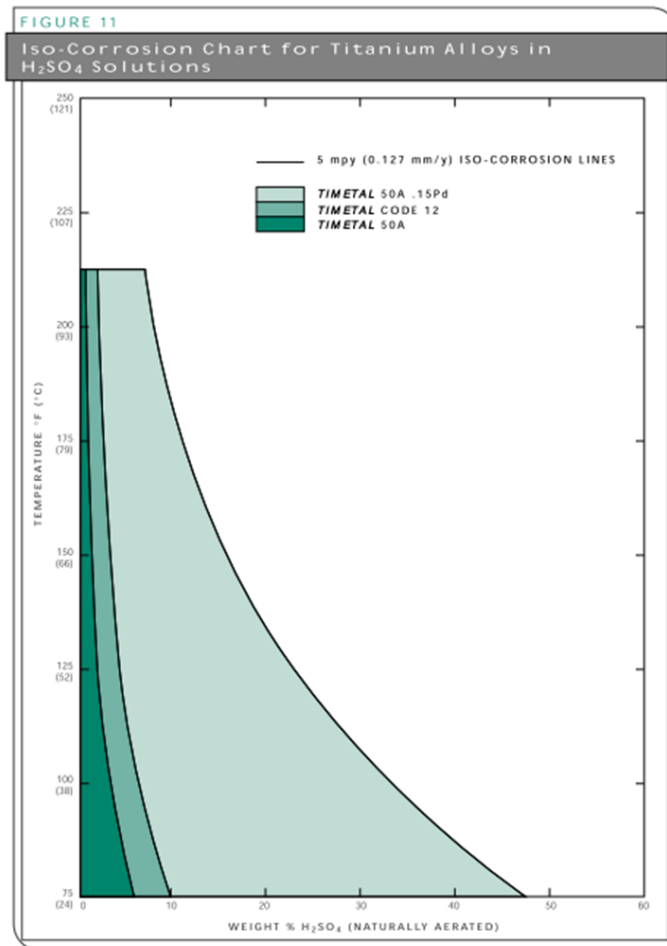


Figure 4 Isocorrosion for 3 types of titanium alloys in  $H_2SO_4$  media. 50a is a ASTM grade 2 and Code 12 concerns ASTM grade 12  
(source: <https://www.timet.com/assets/local/documents/technicalmanuals/corrosion.pdf>)



Table 8 Indicative material selection for equipment

| Tag in flow sheet | Item                                        | Suggested material                     |
|-------------------|---------------------------------------------|----------------------------------------|
|                   | Piping on mother liquor > 82°C              | Duplex, superduplex or GRP,            |
|                   | Piping on mother liquor < 82°C              | PVC-C, 316L, duplex, GRP               |
|                   | Piping on condensate streams                | 316L or GRP or plastic                 |
| 300PP-01          | Circulation pump                            | Superduplex                            |
| 300PP-02          | Condensate pump                             | Plastic or 316                         |
| 300PP-03          | Slurry pump                                 | duplex or superduplex                  |
| 300PP-04          | Product condensate pump                     | Plastic or 316                         |
| 300PP-05          | Liquid Ring vacuum pump                     | SS 316                                 |
| 300PP-06          | Mother liquor pump                          | duplex or superduplex                  |
| 300HE-01          | Heat exchanger for circulation (shell side) | SS 316L                                |
| 300HE-01          | Heat exchanger for circulation (Tube side)  | Hastelloy C276 (optional Superduplex)  |
| 300SC-01          | Separator vessel                            | Rubber lined vessel                    |
| 300HE-02          | Plate condenser                             | SS-316                                 |
| 300TK-01          | Condensate vessel steam                     | SS-316                                 |
| 300TK-02          | Condensate vessel                           | SS-316                                 |
| 300HC-01          | Hydrocyclone                                | GRP or steel with ceramic/glass lining |
| 300TK-03          | Mother liquor tank                          | SS-316                                 |

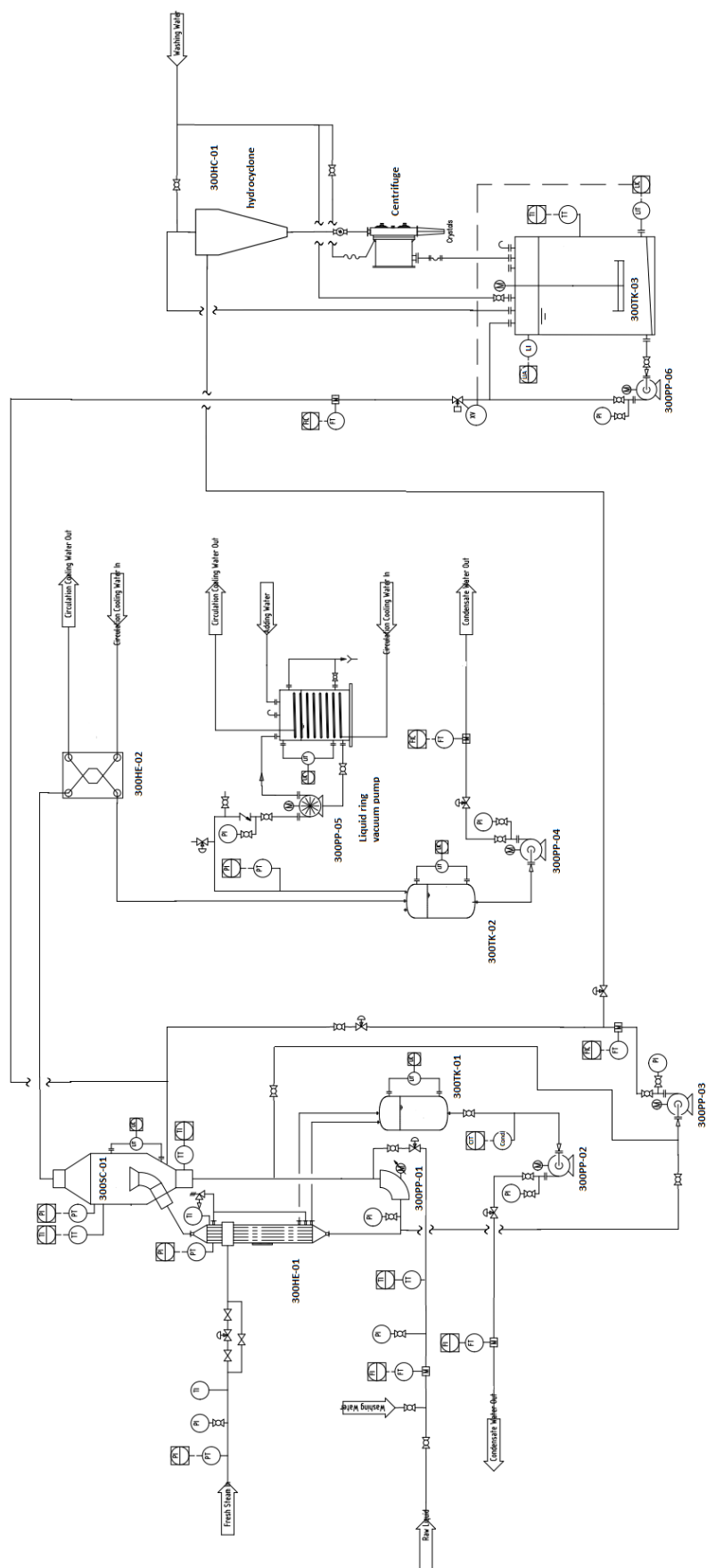


Figure 5 Flow sheet single effect crystallizer

## 5.3 Technical design requirements

### 5.3.1 Dimensions

The setup is placed indoors which gives some restrictions in the maximum dimensions. The total setup has a maximum height of 9.0 meters (warehouse height). The maximum footprint is 10 by 3,0 meter.

### 5.3.2 Climate

The setup for both lots will be placed in a warehouse. Temperature changes (can vary between 5-30°C in the warehouse) between summer and winter no weather influence is expected.

### 5.3.3 Capacity and feed material

- The installation must be able to crystallize ZnSO<sub>4</sub> monohydrate from a 150-180 g/l ZnSO<sub>4</sub>-solution with a density of 1.3-1.4 g/ml at a pH ranging between 3.5-6.0.
- The installation must be able to crystallize 530 kg/h ZnSO<sub>4</sub> monohydrate. This corresponds to a liquid flow of approximately 1.3m<sup>3</sup>/h ZnSO<sub>4</sub>-solution with a density of 1.3-1.4 g/ml at a pH ranging between 3.5-6.0 (Stream <6> from Table 7).
- The system must be capable of evaporating 1 000 kg per hour of water from the mother liquor (Stream <3> from Table 7).

### 5.3.4 Material selection

- As discussed in section 5.2.6 the crystallizing equipment is subjected to high temperatures and chlorides. All material in contact with the liquid and crystals are to be evaluated on their corrosion resistance.

### 5.3.5 Certificates documents, datasheets, manuals and directives

- The installation is provided with technical datasheets and manuals for all equipment installed e.g. electromotors, (electrical) instruments and pumps.
- The installation is provided with electrical and wiring diagrams.
- The installation is delivered with a user manual.
- The installation is delivered with a maintenance guide.
- The installation is delivered with a CE marking (manufacturer's declaration that products comply with the EU's New Approach Directives).
- The installation is delivered conform the Machinery Directive 2006/42/EC.

## 5.4 Additional requirements

### 5.4.1 Training

- The tenderer will provide a training for operators on how to use the machine. This training takes place on the delivery address and requires a minimum of 2 days.

### 5.4.2 Consumables

- The installation is delivered with all consumables regarding maintenance for the first 5000 operating hours.

### **5.4.3 Hazard and operability study**

- The tenderer provides one technical adequate employee for a minimum of 2 days to support the Hazard and Operability study (HAZOP) of the installation and its integration within the demonstration plant.

## 6. Requirements Lot 3: Drying equipment combined with a silo

This chapter contains all information about the tender document deliverables, design specifications and requirements for Lot 3: Drying equipment combined with a silo.

### 6.1 Tender document deliverables

A complete subscription to Lot 3 must include the following documents:

1. Subscription form ('Attachment C. Subscription form tenderer')
2. Uniform Europees aanbestedingsdocument (Document in tender folder)
3. Quotation
4. Reference projects
5. Time schedule
6. Technical data
7. Service and Maintenance schedule

More information regarding the requirements for these documents is provided in the next sections.

#### 6.1.1 Subscription form

The tenderer must deliver a filled-out, duly signed copy of 'attachment C. Subscription form tenderer' in a .pdf format for this lot.

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Attachment C. Subscription form tenderer - 'company name'*

#### 6.1.2 Uniform Europees aanbestedingsdocument

The tenderer must deliver a filled-out, duly signed Uniform Europees aanbestedingsdocument in a .pdf format for this lot. Unfortunately, it is not possible to create this document in English.

The file can be found in the tender documents under the name: 'uea\_279478\_20201016135757.pdf'

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *uea\_279478\_20201016135757 - 'company name'*

#### 6.1.3 Quotation

The submitted quotation includes all requirements set in this document. This quotation is built up by specifying the following elements:

- Engineering costs
- Equipment costs
  - Specification of main equipment items
- Transport and installation costs

The quotation document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Quotation lot 3 - 'company name'*

#### 6.1.4 Reference projects

To guarantee the technical competence of the tenderer, the contracting entity requires tenderers to show references that the tenderer has the necessary competences regarding this lot for which the tenderer has registered. The tenderer must deliver a reference project document with the subscription to show their references. References are indicated by means of two or more assignments carried out in the past ten years. The previous assignments do not exactly have to match the requirements set in this document but do need to give an indication that the tenderer has the competence to realize this lot. Of course, a very comparable and relevant reference project will have a positive effect on the awarded score. The reference project document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Reference projects lot 3 - 'company name'*
- Maximum of 4 a4.
- Include a minimum of 2 projects

#### 6.1.5 Time schedule

The tenderer must deliver a time schedule showing least the following items:

- Detailed Design / Engineering phase (Elemental will provide a basic design and concept);
- Quality Control (QC) reviews on design (design/engineering phase);
- QC approval for construction (end of (component) design/engineering phase) – milestone(s);
- Construction phase (this phase can be split up per component);
- Orders and Deliveries of material – milestones;
- QC approval for painting – milestone(s);
- QC approval for assembly (check on paint) – milestone(s);
- QC review on documentation 3.2;
- Assembly phase;
- FAT;
- Approval on FAT – milestone;
- Delivery of crystallizer system – milestone;
- QC (final) review on documentation;
- **Total delivery time (delivered at place)**
- Payment schedule

The document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Time schedule lot 3 - 'company name'*

### 6.1.6 Technical data

A tender subscription requires a comprehensive description of their scope of supply, including technical specifications with relevant technical, required utilities (steam, power, plant air, cooling water, etc.) and performance data, to enable a proper evaluation. **Specifically note the steam/energy consumption per kilogram of water evaporation in this file.** The design and its according documentation will be made according to the Machinery Directive 2006/42/EC.

The technical data document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Technical data lot 3 - 'company name'*

### 6.1.7 Service and maintenance schedule

A tender subscription requires a description of the expected maintenance activities including a schedule of regular inspections. List of initial spare parts and consumables. This document must also include an hour unit rates for work provided at site.

The service and maintenance schedule document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *Service and maintenance schedule lot 3 - 'company name'*

### 6.1.8 Warranty

A tender subscription requires a document description of the warranty given by the tenderer. Mention and clearly describe the warranties and the associated conditions. E.g. when wear parts are mentioned, the specific wear parts need to be fully mentioned; reference must be made to a proper instruction for cleaning and maintenance; etc. With respect to corrosion of metal equipment a warranty of at least 18 months is asked for.

The warranty document must comply to the following requirements:

- Delivered in the .PDF format
  - File name: *warranty document lot 3 - 'company name'*

## 6.2 Process information

Before listing technical design specifications some additional information about the process is provided in this section.

### 6.2.1 Input Material

The solids which will be fed to the dryer system is the output from the centrifuge. The system will be positioned in a way that the output of the centrifuge falls under gravity in the feeding system of the dryer. Table 9 shows some design properties of the input material:

Table 9 Input material drying equipment

| Specification<br>input material                                     | Zinc sulfate monohydrate                 |
|---------------------------------------------------------------------|------------------------------------------|
| Chemical formula                                                    | $\text{ZnSO}_4 \cdot \text{H}_2\text{O}$ |
| Appearance                                                          | Pasty                                    |
| Properties                                                          | Sticky (expected)                        |
| Particle shape                                                      | Irregular                                |
| Expected moisture content                                           | 5-10%                                    |
| Capacity wet crystals (kg/h)                                        | 550                                      |
| Capacity dry weight crystals (kg/h)                                 | 500                                      |
| Particle size distribution ( $\mu\text{m}$ )                        | 50-200                                   |
| Temperature of cake/crystals                                        | $>65^\circ\text{C}$                      |
| Dry bulk density (kg/l)                                             | 1,40                                     |
| Solid density (kg/l)                                                | 3,08-3,29                                |
| Specific heat capacity anhydrous (kJ/kg K)*                         | 0,68 – 0.75 (363 K – 430 K)              |
| Dehydration temperature of $\text{ZnSO}_4 \cdot \text{H}_2\text{O}$ | $>200$                                   |
| pH of moisture                                                      | 4-5                                      |
| Max expected chlorides in moisture                                  | 35 000 ppm                               |
| Composition moisture                                                | Saturated $\text{ZnSO}_4$ in water       |
| Kind of moisture                                                    | Unknown                                  |

\*<https://webbook.nist.gov/cgi/cbook.cgi?ID=C7733020&Mask=1EFF&Type=JANAFS&Plot=on#JANAFS>

### 6.2.2 Proposed Technology

The following technologies can be offered for drying of the crystals:

- Fluid bed dryer
- Flash dryer
- Paddle dryer
- Spray dryer

Any other drying technology suitable for this application not listed above can be offered as well.

### 6.2.3 General flow sheet, battery limits, mass balance and process description

A general indicative flow sheet shown Figure 6 applies to the required system. The  $\text{ZnSO}_4$  crystals fall under gravity from the centrifuge via a shut towards the feeding inlet of the dryer. In Figure 6 the battery limits are presented within the red dotted square. The system requires drying equipment including a heating system, a silo and air filters for dedusting.

**Optionally**, a big bag filling station can be offered. The big bags must be filled with solids from the silo. The big bags must be weighed with a calibrated scale (with required documentation and certification for sales). **Please add a second quotation with a subscription to this tender.**



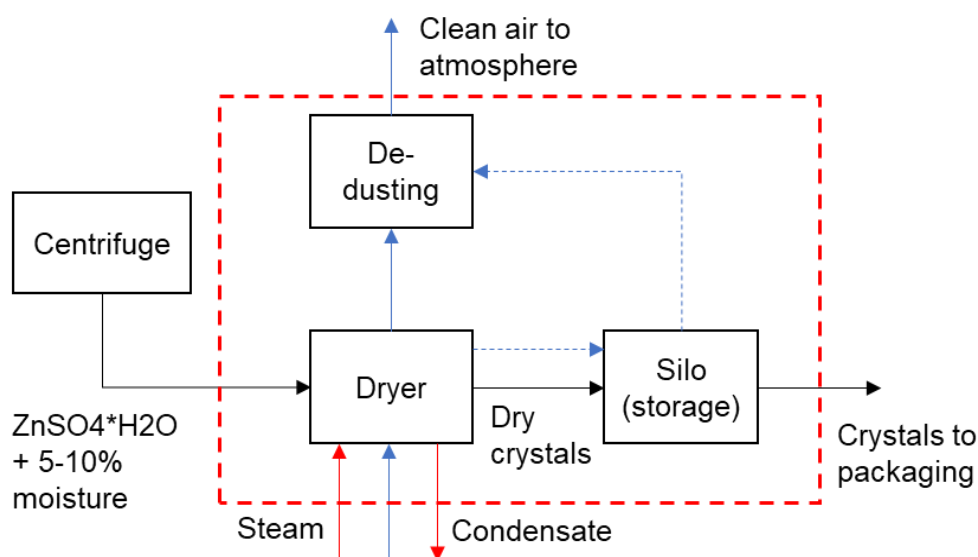


Figure 6 General flowsheet drying equipment and silo

| Design specifications             |                                                    |
|-----------------------------------|----------------------------------------------------|
| Material to be dried              | Zinc Sulfate monohydrate                           |
| Output Rate Per Hour              | 0,5 ton/h                                          |
| Initial Moisture Content          | Max 10%                                            |
| Desired Moisture Content          | <0,5%                                              |
| Ambient Temperature               | 5-30°C                                             |
| Initial Product Temperature       | 65°C                                               |
| End Product Temperature           | <50°C                                              |
| Max temperature of heating medium | 180°C                                              |
| Heating medium air                | Steam (18 bar, can be reduced to desired pressure) |
| Electrical supply                 | 400V                                               |

Table 10 Design specifications drying equipment

## 6.3 Technical design requirements

### 6.3.1 Dimensions

The setup is placed indoors which gives some restrictions in the maximum dimensions. The total setup has a maximum height of 9.0 meters (warehouse height). The maximum footprint is 7,0 by 3,0 meter.

### 6.3.2 Climate

The setup for both lots will be placed in a warehouse (indoors). Temperature changes (can vary between 5-30°C in the warehouse) between summer and winter no weather influence is expected. The site location is approximately at sea level. This location has a barometric pressure between 1013,2 - 1017,0 hPa

### 6.3.3 Capacity and feed material

- The installation must be able to dry a 550 kg ZnSO<sub>4</sub> monohydrate stream to <0.5% moisture (for more details on the feed material see Table 10).

- The installation must be capable of transporting the dried material into the silo.
- The installation is provided with air filters to preventing dust flying into the warehouse.
- The silo has a minimal capacity of 15m<sup>3</sup>
- The material in the silo is very hydrophilic, the silo must be closed and designed in such a way moisture from the surroundings cannot get to the product inside the silo.
- The silo is placed on 4 support legs
- The silo has a minimal distance of 2m between the ground and bottom outlet.
- The bottom outlet is provided with a closing valve applicable for the ZnSO<sub>4</sub> solids.

#### **6.3.4 Material selection**

- The drying equipment is made from a corrosion resistant material for the feed material at the given process conditions. Mind that the crystals are coming from the crystallizer equipment from lot 2 and the liquid has the same composition as the mother liquor in the crystallizer (see Table 6). Mind, the lower operating temperature applicable for the drying equipment.
- The silo is made from a corrosion resistant material for the feed material at the given process conditions. Mind that the crystals are coming from the crystallizer equipment from lot 2 and the liquid has the same composition as the mother liquor in the crystallizer (see Table 6). Mind the lower (compared to conditions in the crystallizer) temperature of the crystals in the silo

#### **6.3.5 Certificates documents, datasheets, manuals and directives**

- The installation is provided with technical datasheets and manuals for all equipment installed e.g. electromotors, (electrical) instruments and pumps.
- The installation is provided with electrical and wiring diagrams.
- The installation is delivered with a user manual.
- The installation is delivered with a maintenance guide.
- The installation is delivered with a CE marking (manufacturer's declaration that products comply with the EU's New Approach Directives).
- The installation is delivered conform the Machinery Directive 2006/42/EC.

### **6.4 Additional requirements**

#### **6.4.1 Training**

- The tenderer will provide a training for operators on how to use the machine. This training takes place on the delivery address and requires a minimum of 2 days.

#### **6.4.2 Consumables**

- The installation is delivered with all consumables regarding maintenance for the first 5000 operating hours.

#### **6.4.3 Hazard and operability study**

- The tenderer provides one technical adequate employee for a minimum of 1 day to support the Hazard and Operability study (HAZOP) of the installation and its integration within the demonstration plant.