



Sand Deposit Control Strategy on Centrifugal Pump Type Overhung 4 Size 4x11 Using API 682 Piping Plan 13

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Abstract

Centrifugal pumps type Overhung 4 size 4x11 often experience sand deposits and erosion problems, especially in the oil and gas industry, resulting in reduced productivity and increased repair costs. This study evaluates the application of the Piping Plan 13 API 682 as a solution to this problem. The 5-Why Analysis method is used to identify the root cause of sand deposits, which were associated with sand contamination from a liquid source and the absence of an effective filtering system. The implementation of Piping Plan 13 aims to prevent sand deposits in critical areas, such as the Pedestal Cover and Pedestals, by leveraging the circulation design of the pipeline. The results showed a 19.75% increase in pump productivity and a 76.12% reduction in repair costs. Productivity increases reached 336,000 barrels (about 53,419,731 liters) over 16 days of operation, while the repair cost fell from Rp6,699,950 to Rp1,600,000. These findings indicate that Piping Plan 13 API 682 is an effective solution to increase the life and performance of the centrifugal pump and reduce maintenance costs in operating conditions with high sand contamination.

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Abstrak

Pompa sentrifugal jenis Overhung 4 size 4x11 sering mengalami masalah endapan pasir dan erosi, terutama dalam industri minyak dan gas, yang mengakibatkan penurunan produktivitas dan peningkatan biaya perbaikan. Penelitian ini mengevaluasi penerapan Piping Plan 13 API 682 sebagai solusi untuk mengatasi permasalahan ini. Metode 5-Why Analysis digunakan untuk mengidentifikasi akar penyebab endapan pasir, yang ditemukan terkait dengan kontaminasi pasir dari sumber cairan dan ketiadaan sistem penyaringan efektif. Implementasi Piping Plan 13 bertujuan untuk mencegah endapan pasir di area kritis seperti Pedestal Cover dan Pedestal, dengan memanfaatkan desain sirkulasi perpipaan. Hasil penelitian menunjukkan peningkatan produktivitas pompa sebesar 19,75% dan penurunan biaya perbaikan sebesar 76,12%. Peningkatan produktivitas mencapai 336.000 barrels (sekitar 53.419.731 liter) selama 16 hari operasional, sedangkan biaya perbaikan turun dari Rp6.699.950 menjadi Rp1.600.000. Temuan ini mengindikasikan bahwa Piping Plan 13 API 682 adalah solusi efektif untuk meningkatkan umur dan kinerja pompa sentrifugal serta mengurangi biaya perawatan dalam kondisi operasi dengan kontaminasi pasir tinggi.

1. Introduction

This A pump is a hydraulic engine that converts mechanical energy into hydraulic energy (in the form of pressure) and mechanically moves fluids (liquid, semi-aqueous, gas, and sometimes slurry) from low pressure to high pressure (Idris & Tijjani, 2024). Centrifugal pumps are widely used in a variety of industrial processes, including the oil and gas industry, due to their reliability, high durability, and high flow rates at affordable prices (Zanini et al., 2023). Centrifugal pumps are of many kinds, one being the overhung type.

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Overhung pumps are a type of pump commonly used in the oil and gas industry. These overhung pumps were usually designed with impellers hanging at the tip of the shaft (Sarabchi et al., 2023). The pump serves as a transportation of crude oil from the offshore drilling plant to the central plant. However, these pumps often face harsh operating conditions, such as sand and other particles, which can cause significant drainage (Ekeberg et al., 2022). One common problem is sand deposits inside the pump, especially on the cover and pedestal pedestals, which can lead to reduced productivity and increased maintenance costs.

The extraction process can contaminate crude oil with sand in the oil and gas industry, especially when the oil well conditions are thin. These sand-containing fluids can damage pump components, reducing productivity and costly repairs (Zhu et al., 2021). Therefore, an effective strategy for controlling sand deposits is essential to enhance the long life and performance of the Centrifugal pump type overhung 4x11.

This study uses Piping Plan 13 API 682, whose primary function is to return fluids from the seal chamber to the suction pump to maintain pressure and temperature stability on the mechanical seal (American Petroleum Institute 682, 2014). This plan 13 piping is re-functioned to control the sand deposits on the centrifugal pump, thus preventing the accumulation of abrasive particles in the Pedestal Cover and Pedestals area and ensuring optimal pump performance in high sand-containing operating conditions.

The study's objective is to analyze the root causes of sand deposits and their impact on pump components, especially pedestal covers and pedestals. Furthermore, the study aims to analyze the impact of improvements to reduce maintenance costs and improve pump operational productivity. The study involved applying API 682 Piping Plan 13 as a solution to reduce sand deposits and improve pump performance.

2. Research Methods

This study uses the 5-Why Analysis method, which is a technique used to find the root of the problem by asking the "why" question five times (Wirawan & Minto, 2021). This method is applied to determine the cause of the sand deposits that occurred on an overhung 4 size 4x11 centrifugal pump, using data obtained through interviews with the pump repair engineer to reveal the root causes of the problem in greater depth.

2.1 Pump Specification

Before starting further analysis, it is important to understand the technical specifications of the Centrifugal pump type overhung 4 size 4x11 that are the subject of this study. This specification gives an overview of the capabilities and characteristics of the pump. Here is the complete specification table of the pump:

Table 1. Centrifugal Pump type Overhung Specification

Description	Specification
Manufacture	United Centrifugal Pump
Type	4 x 11 VP
Capacity	1050 GPM
Head	300 Ft
Type of Impeller	Closed Impeller
Impeller	10.00 Inch
Diameter	
Suction	20 Psi
Discharge	180 Psi
Mechanical Seal	DMSF 1.875"
Speed	3575 RPM
Motor Power	150
Flow Rate	21.000 BFPD (Barrels of Fluids per day)

2.2 Sand Deposit Area and Damage Occurred

A thorough understanding of the area of sand deposits and the damage that occurs to the pump is vital to observe. Sand deposits can cause various damage to the pump components, especially the pedestal cover and pedestals. To give a clear picture of the location of the deposits and the damage that occurred, the following images show the area and damage that occurred to the pedestal cover and pedestals of the centrifugal pump type overhung four sizes 4x11 can be seen in **Figure 1** and **Figure 2**.

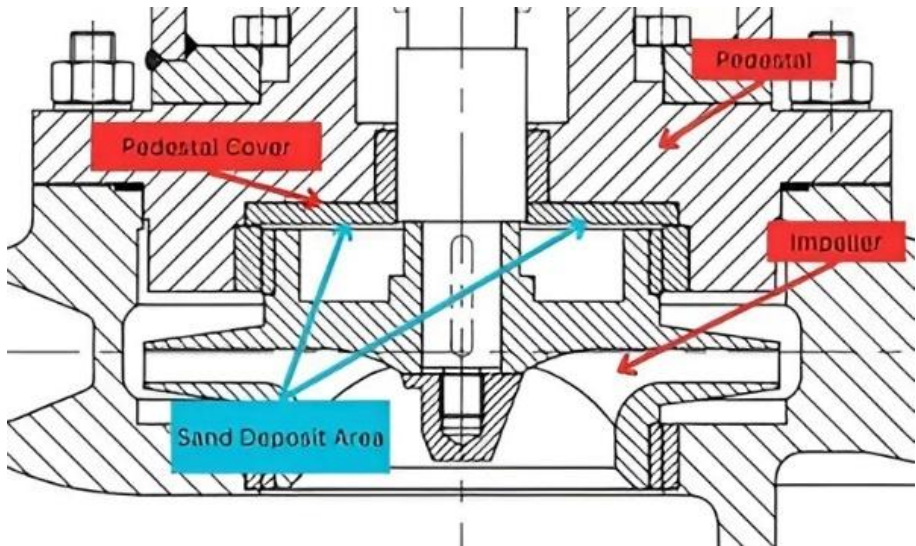


Figure 1. Sand Deposit Area (Document PT. XYZ)



Figure 2. Damage that occurs to the pedestal cover and pedestal (Documentation PT. XYZ)

2.3 Pump Schematic Diagram

To understand the configuration and process flow in the field in a Centrifugal pump type overhung 4 size 4x11 system, it is important to look at the Piping and Instrumentation Diagram (P&ID). This diagram provides a complete overview of how the pump components are connected and how fluid flow occurs in the system (Yu et al., 2019). This will help in analyzing the causes of the sand deposits. Here's a P&ID image of the pump system studied, which can be seen in Figure 3.

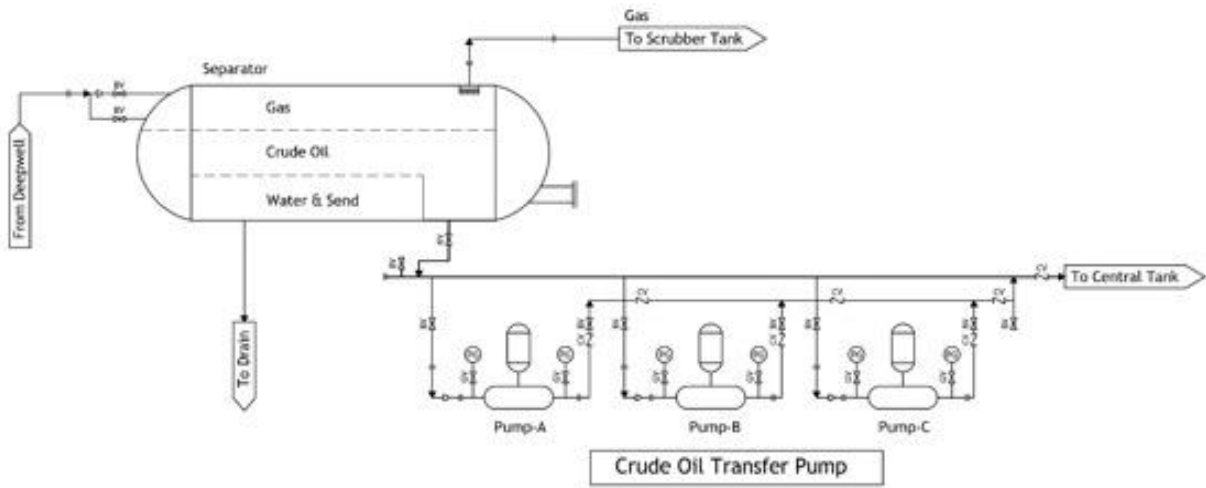


Figure 3. Piping and Instrumentation Diagram Centrifugal Pump type Overhung 4 size 4x11 (Document PT. XYZ)

It can be seen from the image above that the pump is used as a crude oil transfer pump from the perforation area to the crude oil storage center. The pump sucks fluid from the tank separator, which serves as a phase separator and a fluid filtration system before entering the pump.

2.4 Running Hour Pump before Implementation API 682 Piping Plan 13

We need to look at the pump running hour data to give an overview of the pump performance before applying API 682 Piping Plan 13. Running hour refers to the pump life from when the pump starts operating until damage occurs. Here is a table that shows the pump's running hours before the implementation of API 682 Piping Plan 13, as seen in **Table 2**.

Table 2. Running Hour Pump (Field Data PT. XYZ)

Pump Type	Running Hour
Overhung 4 size 4x11 VP	1944

2.5 Implementation API 682 Piping Plan 13

Before displaying a picture of the implementation of the API 682 Piping Plan 13, it is important to explain how this piping plan is applied to the centrifugal pump system being studied. The implementation aims to improve the performance and durability of the pump by reducing sand deposits and the risk of damage. This installation works by exploiting the difference between the suction pressure and the seal chamber pressure so that it can create a circulation pathway (American Petroleum Institute 682, 2014). These circulation paths serve to prevent sand deposits in vulnerable areas, such as the Pedestal Cover and Pedestal. The following figure will show in detail how the API 682 Piping Plan 13 is applied, including the modifications made to the piping system and the additional components installed to that goal. Implementation of the API 682 Piping Plan 13 circulation line can be seen in **Figure 4** and **Figure 5**.

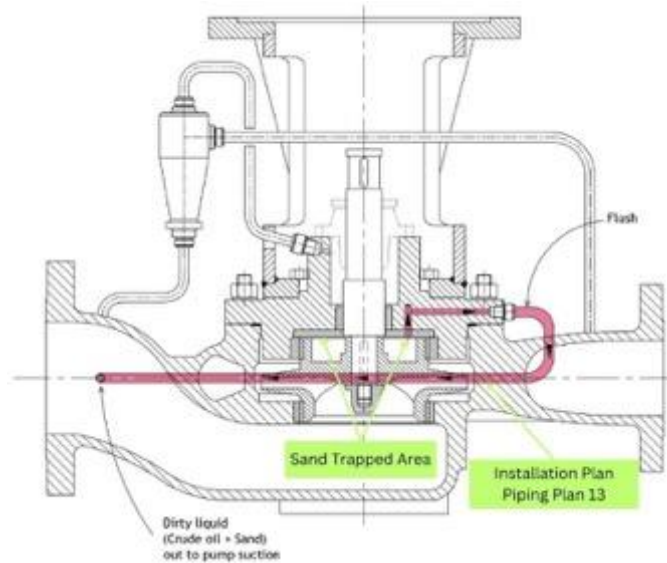


Figure 4. Sectional Drawing Installation Plan API 682 Piping Plan 13



Figure 5. Installation API 682 Piping Plan 13

3. Results and Discussions

This section outlines the results of research that has been carried out, which includes an in-depth analysis of the root causes of the problem as well as the impact of the solutions implemented. To understand the roots of the problems, this study starts with the 5-Why Analysis (Barsalou & Starzyńska, 2023), then looks at how the application of solutions can increase productivity and lower the cost of repairs.

3.1 5-why Analysis

To strengthen understanding of the root causes of sand deposits and erosion in centrifugal pumps, analysis is conducted using the 5-Why Analysis method. The analysis focuses on identifying the root cause of the underlying problem. Based on data obtained from interviews with the engineering repair team at PT XYZ. Here are the results of the 5-Why Analysis can be seen in **Table 3**.

Table 3. 5-Why Analysis

5-Why Analysis		
No	Q/A	Statement
1	Q	Why are sand deposits and erosion found inside the centrifugal pump?
	A	Sand and fluid are transported through the pump and cause erosion and deposits.
2	Q	Why is the sand transported with the liquid?
	A	Liquid sources contain high and fine sand.
3	Q	Why does a liquid source contain high and fine sand?
	A	Diminishing well conditions cause crude oil to be contaminated with sand.
4	Q	Why is the thinner well condition causing crude oil to be contaminated with sand?
	A	There's no filtering system to prevent fine sand from entering the pump.
5	Q	Why is there no effective filtering system to prevent small sand from entering the pump?
	A	If there is a filtering system, it will block and cause cavitation on the pump.

The results of the 5-Why Analysis show that the sand deposits and erosion of the Centrifugal pump type Overhung 4 size 4x11 are caused by the contamination of the sand in the fluid carried by the pump, which is rooted in thin well conditions and the absence of an effective filtering system. To address the root cause of this damage, the implementation of the Piping Plan 13 API 682 was designed to prevent sand in the Pedestal Cover and Pedestal Areas. Thus, the application of the piping plan 13API 682 is a suitable solution to reduce the impact of sand deposits to improve pump performance and reduce repair costs.

3.2 Increased Productivity

Productivity improvement of the Centrifugal pump type Overhung 4 size 4x11 has a Running Hour and Flow Rate reference of the pump based on field data and pump specifications. From the specification data obtained that the Flow rate of the Centrifugal pump type overhung 4 sizes 4x11 is 21.000 BFPD (Barrels of Fluida per day) or about 3.338.733,2 liters/day. For a comparison of the running hour of this pump can be seen in **Table 4**.

Table 4. Running Hour (PT XYZ Document)

Pump Type	Running Hour (/hour)	
	Before	After
Overhung 4 sizes 4x11	1944	2328

From the running hour comparison table, it is seen that after the improvement, there is an increase in the pump's operating hours by 19.75%. This difference is equivalent to 384 hours or about 16 days of pump operation. So, the increase in productivity can be explained as follows:

$$x = Q \times t \quad (1)$$

Where x is the increase in productivity, which is 21000 BFD, and t is the time in days, which is 16 days. From the calculation using equation 1, it's known that the increase in productivity over 16 days can yield up to 336000 barrels or about 53,419,731 liters.

To enhance pump capacity following maintenance, it is crucial to implement strategies such as optimizing pump settings, utilizing variable-speed drives, and ensuring proper system alignment (Bhandari, 2024). Quality control and regular maintenance are proven to increase and maintain pump productivity (Okirie, 2024). Improving the pedestal has also significantly boosted pump productivity by providing better support and stability, reducing vibrations and wear on the pump components.

3.3 Reduction in repair costs

One important impact of implementing the identified solution is the reduction in repair costs. Table 5 compares the damage to the Pedestal Cover and Pedestals before and after the improvement that occurred on the Centrifugal pump type Overhung 4 size 4x11.

Table 5. Image of damage before and after installation Piping Plan 13 API 682

No	Name	Before	After
1	Pedestal Cover		
2	Pedestal	 	 

It is seen from **Table 5** that the Pedestal Cover and Pedestal had previously suffered damage due to erosion and corrosion on their surfaces, and after improvement, the pedestal cover and pedestals were only subjected to surface corrosion due to exposure to seawater fluids during the maintenance of the tank separator. This corrosion and erosion might occur in the pump due to suspended solids in the fluid (LEE & LIM, 2009). The image of damage prior to improvement indicates that the pedestal cover suffers from erosion damage, so it cannot be repaired and must be re-fabricated. Meanwhile, Pedestals require significant repairs because the dimensions wasted by erosion must be replenished using welding and machining methods.

After improvement, the cost of repairs can be reduced as the Pedestal Cover can still be repaired with the sandblasting and coating methods. Sandblasting is a common method to clean corrosion on a metal surface (Ding & Poursaee, 2017), while Pedestals can also be fixed with the sandblasting method. Below is a table of improvement costs before improvement can be seen in **Table 6**.

Table 6. The cost of repairs before improvement

No	Bill Of Material Description	UOM	QTY	Sell Unit Price (IDR)	Total Price (IDR)
1	Repair Pedestal (including Painting)	Ea	1	4,749,300	4,749,300
2	Fabricate Pedestal Cover Plate	Ea	1	1,950,650	1,950,650
Total					6,699,950

Table 6 shows that the cost of repairs before improvement amounted to Rp6,699,950, and Table 7 shows the Cost of Repairs after improvement.

Table 7. The cost of repairs after improvement

No	Bill Of Material Description	UOM	QTY	Sell Unit Price (IDR)	Total Price (IDR)
1	Repair Pedestal (including Sandblasting & Painting)	Ea	1	1,000,000	1,000,000
2	Repair Pedestal Cover (including Coating abrasive resistance and sand Blasting)	Ea	1	600,000	600,000
Total					1,600,000

Table 7 shows that the cost of repairs after improvement was Rp1,600,000. It shows a cost reduction of 76.12% after the improvement. This significant cost reduction must be maintained by tracking the maintenance (Funmilayo & Saturday, 2023) and monitoring pump performance (Moreno et al., 2007)

4. Conclusions

This research has evaluated the effectiveness of the implementation of the Piping Plan 13 API 682 on the Centrifugal pump type Overhung 4 size 4x11 in addressing the problem of sand deposits and erosion. Centrifugal pumps, which are often used in the oil and gas industry, face significant challenges due to sand contamination, which leads to reduced productivity and high repair costs. Through 5-Why analysis, it was identified that sand deposits were caused by sand contamination in fluids and the absence of an effective filtration system, which led to erosion and sand deposits on the pump components.

Implementing the Piping Plan 13 API 682 effectively addresses this problem by preventing sand deposits in the Pedestal Cover and pedestal areas and improving pump productivity. Data before and after implementation showed a 19.75% increase in productivity, with an additional 336,000 barrels (about 53,419,731 liters) over 16 operational days. In addition, the cost of repairs dropped significantly by 76.12%, from Rp6,699,950 to Rp1,600,000.

Overall, the Piping Plan 13 API 682 proved to be the right solution for increasing the life and performance of the Centrifugal pump type Overhung 4 size 4x11 and reducing maintenance costs, making it an effective choice for industrial applications facing high sand contamination.

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