CHAPTER V
CONCLUSION AND SUGGESTION

5.1 Conclusion

Based on the analytical calculations, the PipeFlow Expert simulations, and the optimization scenario analysis performed on the piping system of the Water Treatment Injection Plant of PT Pertamina Hulu Rokan, the following conclusions can be drawn:

1. **Centrifugal Pump Specifications**

The analytical calculations produced the following centrifugal pump specifications:

Feed Pump (P-110 A/B/C):

a. Total Dynamic Head = 226.12 ft = 68.92 m
b. Design capacity = 6000 BWPD = 39.75 m^3/h
c. NPSHa = 36.29 ft = 11.06 m — aman dari risiko kavitasi
d. Hydraulic Horse Power = 10.04 HP = 7.49 kW
e. Brake Horse Power = 16.74 HP = 12.48 kW

Injection Pump (P-111 A/B/C):

a. Total Dynamic Head = 2077.62 ft = 633.0 m
b. Design capacity = 6000 BWPD = 39.75 m^3/h
c. NPSHa = 36.22 ft = 11.04 m — aman dari risiko kavitasi
d. Hydraulic Horse Power = 91.72 HP = 68.40 kW
e. Brake Horse Power = 152.87 HP = 114.0 kW

The analytical calculation results show agreement with the engineer document with a maximum difference of 0.041%, which validates the calculation method used.

2. PipeFlow Expert Simulation Validation

The PipeFlow Expert simulation produced a Feed Pump head of 73.60 m and an Injection Pump head of 522.1 m. The difference from the analytical calculation results is caused by two factors: first, the software calculates the actual operating point based on the intersection of the pump curve and the system curve; second, the

engineer added safety margins in the form of ΔP_other = 50 psig and ΔP_allowance = 57.64 psig, which are not modeled in the basic hydraulic simulation. This shows that the engineer design is conservative with adequate safety margins..

3. System Curve Analysis

The system curves show that both pumps operate in a system dominated by pressure head. In the Feed Pump, friction losses contribute 2% of the total TDH, while in the Injection Pump they contribute only 0.04%. This characteristic determines the most effective optimization strategy for each pump.

4. Optimization of Pump Specifications and Piping System

Of the three optimization scenarios analyzed, Scenario C, which combines an increase in discharge pipe diameter and pump efficiency, provides the best overall results:

a. Feed Pump: diameter discharge 4 inch → 5 inch, efficiency 60% → 75%
b. Injection Pump: diameter discharge 6 inch → 8 inch, efficiency 60% → 75%
c. Total system energy savings = **Rp 1,142,784,000 per year**
d. A 31.7% reduction in Feed Pump discharge velocity, which extends pipe service life
e. A 43.6% reduction in Injection Pump discharge velocity, which reduces erosion risk

5.2 Suggestion

Based on the results of this study, the following recommendations can be given:

1. For PT Pertamina Hulu Rokan

The efficiency improvement does not necessarily require full pump replacement. It can be achieved more economically through impeller trimming, installation of a variable speed drive, or by scheduling the upgrade during planned maintenance intervals. Phased implementation, prioritizing the injection pump with the largest saving potential, further reduces the capital burden while capturing most of the annual energy saving.

Consider implementing Scenario C in stages, with priority given to replacing the Injection Pump with a high efficiency pump first, considering that it offers the

largest savings potential of IDR 357 million per unit per year without requiring any pipe infrastructure modification.

2. For Future Research

a. Perform the analysis using actual field data (measured flow rates and actual pressures) for more accurate validation against real operating conditions
b. Expand the simulation model to include the entire pipe network, including the flow lines and injection lines, for a more comprehensive system analysis
c. Perform a more detailed economic analysis, including the investment costs of pump and pipe replacement, to calculate the Return on Investment (ROI)
d. Analyze the effect of injection rate variations on system performance to support dynamic operational optimization

3. For Methodology Development

This study shows that the combination of analytical calculation and software simulation provides a more comprehensive understanding than either method alone. This approach is recommended for application in the analysis of other industrial piping systems, especially high pressure systems such as water injection in EOR operations.