

BAB IV

HASIL STUDI KASUS DAN PEMBAHASAN

4.1 Data Pengukuran Pompa Sirkulasi Minyak Sawit A Dan B *Concentrated Solar Power* Tahun 2015

Pada tabel 4.1 sampai dengan tabel 4.24 merupakan kumpulan data yang disajikan dalam bentuk tabel, diperlukan untuk proses perhitungan kinerja pompa sirkulasi minyak sawit pada *Concentrated Solar Power*. Data yang digunakan merupakan data operasional *Concentrated Solar Power* di UPT BPPTK LIPI Yogyakarta terhitung pada bulan Januari hingga bulan Desember tahun 2015. Terdiri dari 3 *shift* yaitu pagi, siang dan sore. *Concentrated Solar Power* di UPT BPPTK LIPI Yogyakarta memiliki 2 unit pompa sirkulasi minyak sawit A dan B. Data yang dibutuhkan untuk proses perhitungan kinerja pompa sirkulasi minyak sawit pada *Concentrated Solar Power* di UPT BPPTK LIPI Yogyakarta terdiri dari *Speed, Suction Pressure, Discharge Pressure, Suction Temperature, Discharge Temperature, kapasitas aliran* dan beberapa data desain pompa sirkulasi minyak sawit yang dibutuhkan untuk perhitungan kinerja pompa sirkulasi minyak sawit *Concentrated Solar Power* di UPT BPPTK LIPI Yogyakarta.

Tabel 4.1 Data pengukuran pompa sirkulasi minyak sawit A Bulan Januari
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2805,67 | 2839,36 | 2857 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,44 | 0,44 | 0,488 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 22,32 | 23,37 | 19,16 |
| 4 | <i>Suction Temperature (°C)</i> | 40 | 39,83 | 41,58 |
| 5 | <i>Discharge Temperature (°C)</i> | 51,5 | 48,83 | 54,66 |
| 6 | <i>Flow (m³/hour)</i> | 4,05 | 4,07 | 4,11 |

Tabel 4.2 Data pengukuran pompa sirkulasi minyak sawit B Bulan Januari
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2799,37 | 2872,50 | 2882,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,41 | 0,45 | 0,43 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,19 | 21,71 | 18,28 |
| 4 | <i>Suction Temperature (°C)</i> | 38,67 | 39,83 | 41,58 |
| 5 | <i>Discharge Temperature (°C)</i> | 47,83 | 48,83 | 54,66 |
| 6 | <i>Flow (m³/hour)</i> | 4,03 | 4,23 | 4,08 |

Tabel 4.3 Data pengukuran pompa sirkulasi minyak sawit A Bulan Februari
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2848,16 | 2833,83 | 2845,73 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,44 | 0,45 | 0,5 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 22,32 | 23,2 | 18,98 |
| 4 | <i>Suction Temperature (°C)</i> | 42,08 | 40,75 | 42,5 |
| 5 | <i>Discharge Temperature (°C)</i> | 53,5 | 50,5 | 55,67 |
| 6 | <i>Flow (m³/hour)</i> | 4,25 | 4,2 | 4,05 |

Tabel 4.4 Data pengukuran pompa sirkulasi minyak sawit B Bulan Februari
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2890 | 2890,66 | 2872 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,41 | 0,45 | 0,46 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,1 | 17,75 | 18,28 |
| 4 | <i>Suction Temperature (°C)</i> | 42,08 | 40,75 | 42,5 |
| 5 | <i>Discharge Temperature (°C)</i> | 53,5 | 50,5 | 55,66 |
| 6 | <i>Flow (m³/hour)</i> | 3,92 | 4,15 | 4,03 |

Tabel 4.5 Data pengukuran pompa sirkulasi minyak sawit A Bulan Maret
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2883 | 2869 | 2878,46 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,46 | 0,45 | 0,52 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 22,06 | 22,85 | 18,98 |
| 4 | <i>Suction Temperature (°C)</i> | 42,58 | 42,75 | 44,5 |
| 5 | <i>Discharge Temperature (°C)</i> | 51,5 | 51 | 55,67 |
| 6 | <i>Flow (m³/hour)</i> | 4,15 | 4,23 | 3,93 |

Tabel 4.6 Data pengukuran pompa sirkulasi minyak sawit B Bulan Maret
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2869,5 | 2868,67 | 2895 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,42 | 0,45 | 0,48 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,93 | 17,31 | 18,28 |
| 4 | <i>Suction Temperature (°C)</i> | 42,58 | 42,75 | 38 |
| 5 | <i>Discharge Temperature (°C)</i> | 51,5 | 51 | 55,67 |
| 6 | <i>Flow (m³/hour)</i> | 4,25 | 4,01 | 4,25 |

Tabel 4.7 Data pengukuran pompa sirkulasi minyak sawit A Bulan April 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2849,67 | 2843,53 | 2869,67 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,48 | 0,45 | 0,54 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 21,97 | 19,68 | 18,72 |
| 4 | <i>Suction Temperature (°C)</i> | 40,25 | 41,41 | 42,67 |
| 5 | <i>Discharge Temperature (°C)</i> | 50,67 | 51,67 | 56 |
| 6 | <i>Flow (m³/hour)</i> | 4,25 | 4,2 | 4,15 |

Tabel 4.8 Data pengukuran pompa sirkulasi minyak sawit B Bulan April 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2868,86 | 2887 | 2904,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,44 | 0,45 | 0,48 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,66 | 16,8 | 17,41 |
| 4 | <i>Suction Temperature (°C)</i> | 40,25 | 41,41 | 42,83 |
| 5 | <i>Discharge Temperature (°C)</i> | 50,67 | 51,66 | 56 |
| 6 | <i>Flow (m³/hour)</i> | 4,11 | 4,1 | 4,3 |

Tabel 4.9 Data pengukuran pompa sirkulasi minyak sawit A Bulan Mei 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2846 | 2845,66 | 2873,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,48 | 0,45 | 0,54 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,63 | 19,68 | 18,63 |
| 4 | <i>Suction Temperature (°C)</i> | 43,16 | 42,16 | 43,83 |
| 5 | <i>Discharge Temperature (°C)</i> | 57,66 | 55,66 | 60 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,35 | 4,25 |

Tabel 4.10 Data pengukuran pompa sirkulasi minyak sawit B Bulan Mei 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2888 | 2891,66 | 2823,66 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,49 | 0,46 | 0,51 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,22 | 16,78 | 17,40 |
| 4 | <i>Suction Temperature (°C)</i> | 43,16 | 42,16 | 43,83 |
| 5 | <i>Discharge Temperature (°C)</i> | 57,66 | 55,66 | 60 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,35 | 4,23 |

Tabel 4.11 Data pengukuran pompa sirkulasi minyak sawit A Bulan Juni 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2879,7 | 2830 | 2850 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,49 | 0,49 | 0,54 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,63 | 18,1 | 18,28 |
| 4 | <i>Suction Temperature (°C)</i> | 41,58 | 42,75 | 44,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 55,5 | 56,5 | 60,5 |
| 6 | <i>Flow (m³/hour)</i> | 4,31 | 4,2 | 4,21 |

Tabel 4.12 Data pengukuran pompa sirkulasi minyak sawit B Bulan Juni 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2828 | 2882,03 | 2878,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,49 | 0,46 | 0,52 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,22 | 16,61 | 17,40 |
| 4 | <i>Suction Temperature (°C)</i> | 41,58 | 42,75 | 45,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 55,5 | 56,5 | 60,5 |
| 6 | <i>Flow (m³/hour)</i> | 4,21 | 4,23 | 4,1 |

Tabel 4.13 Data pengukuran pompa sirkulasi minyak sawit A Bulan Juli 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2835,33 | 2791,66 | 2814 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,54 | 0,51 | 0,55 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,63 | 18,98 | 18,45 |
| 4 | <i>Suction Temperature (°C)</i> | 42,5 | 43,5 | 45,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 56,33 | 57,5 | 60,83 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,2 | 4,18 |

Tabel 4.14 Data pengukuran pompa sirkulasi minyak sawit B Bulan Juli 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2822,33 | 2875 | 2875 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,51 | 0,5 | 0,52 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,48 | 17,13 | 16,87 |
| 4 | <i>Suction Temperature (°C)</i> | 42,5 | 43,5 | 45,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 56,33 | 57,5 | 60,83 |
| 6 | <i>Flow (m³/hour)</i> | 4,3 | 4,1 | 4,15 |

Tabel 4.15 Data pengukuran pompa sirkulasi minyak sawit A Bulan Agustus
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2871,33 | 2858 | 2891 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,54 | 0,49 | 0,48 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,45 | 19,33 | 23,02 |
| 4 | <i>Suction Temperature (°C)</i> | 43,91 | 44,91 | 46,83 |
| 5 | <i>Discharge Temperature (°C)</i> | 56,67 | 57,83 | 61,16 |
| 6 | <i>Flow (m³/hour)</i> | 4,2 | 4,18 | 4,16 |

Tabel 4.16 Data pengukuran pompa sirkulasi minyak sawit B Bulan Agustus
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2882 | 2903,66 | 2883,66 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,4079 | 0,45 | 0,45 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 22,14 | 17,04 | 17,22 |
| 4 | <i>Suction Temperature (°C)</i> | 43,91 | 44,91 | 46,83 |
| 5 | <i>Discharge Temperature (°C)</i> | 56,66 | 57,83 | 61,16 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,13 | 4,2 |

Tabel 4.17 Data pengukuran pompa sirkulasi minyak sawit A Bulan
September 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2433,33 | 2425,13 | 2865 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,55 | 0,49 | 0,53 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,45 | 19,33 | 19,15 |
| 4 | <i>Suction Temperature (°C)</i> | 44,91 | 45,33 | 47,25 |
| 5 | <i>Discharge Temperature (°C)</i> | 57,66 | 57,5 | 60,83 |
| 6 | <i>Flow (m³/hour)</i> | 4,25 | 4,33 | 4,23 |

Tabel 4.18 Data pengukuran pompa sirkulasi minyak sawit B Bulan
September 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2872,33 | 2902 | 2893 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,40 | 0,46 | 0,45 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 21,97 | 17,04 | 17,22 |
| 4 | <i>Suction Temperature (°C)</i> | 44,91 | 45,33 | 47,25 |
| 5 | <i>Discharge Temperature (°C)</i> | 57,66 | 57,5 | 60,83 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,2 | 4,25 |

Tabel 4.19 Data pengukuran pompa sirkulasi minyak sawit A Bulan Oktober
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2826,33 | 2808,43 | 2857,5 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,56 | 0,49 | 0,53 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,45 | 19,15 | 18,98 |
| 4 | <i>Suction Temperature (°C)</i> | 45,41 | 45,83 | 47,75 |
| 5 | <i>Discharge Temperature (°C)</i> | 57 | 56,83 | 60,5 |
| 6 | <i>Flow (m³/hour)</i> | 4,26 | 4,26 | 4,28 |

Tabel 4.20 Data pengukuran pompa sirkulasi minyak sawit B Bulan Oktober
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2856,5 | 2886,83 | 2884,5 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,41 | 0,46 | 0,45 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 21,7 | 17,04 | 17,04 |
| 4 | <i>Suction Temperature (°C)</i> | 45,41 | 45,83 | 47,75 |
| 5 | <i>Discharge Temperature (°C)</i> | 57 | 56,83 | 60,5 |
| 6 | <i>Flow (m³/hour)</i> | 4,28 | 4,25 | 4,26 |

Tabel 4.21 Data pengukuran pompa sirkulasi minyak sawit A Bulan
November 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2872 | 2870,13 | 2449,67 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,56 | 0,49 | 0,54 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,45 | 19,15 | 18,8 |
| 4 | <i>Suction Temperature (°C)</i> | 45,75 | 46,33 | 48,08 |
| 5 | <i>Discharge Temperature (°C)</i> | 59,16 | 59,33 | 62,66 |
| 6 | <i>Flow (m³/hour)</i> | 4,25 | 4,3 | 4,26 |

Tabel 4.22 Data pengukuran pompa sirkulasi minyak sawit B Bulan
November 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2457,5 | 2918,33 | 2886,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,43 | 0,46 | 0,45 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,75 | 16,96 | 16,87 |
| 4 | <i>Suction Temperature (°C)</i> | 45,75 | 46,33 | 48,08 |
| 5 | <i>Discharge Temperature (°C)</i> | 59,16 | 59,33 | 62,66 |
| 6 | <i>Flow (m³/hour)</i> | 4,33 | 4,28 | 4,25 |

Tabel 4.23 Data pengukuran pompa sirkulasi minyak sawit A Bulan
Desember 2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2880,33 | 2850,63 | 2888,16 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,56 | 0,51 | 0,55 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 18,45 | 18,63 | 18,45 |
| 4 | <i>Suction Temperature (°C)</i> | 46,08 | 46,66 | 48,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 59,5 | 59,66 | 63 |
| 6 | <i>Flow (m³/hour)</i> | 4,21 | 4,31 | 4,26 |

Tabel 4.24 Data pengukuran pompa sirkulasi minyak sawit B Bulan Desember
2015

| No | <i>Parameter</i> | Pagi | Siang | Sore |
|-----------|--|-------------|--------------|-------------|
| 1 | <i>Speed (rpm)</i> | 2898,66 | 2897,78 | 2890,33 |
| 2 | <i>Suction Pressure (kgf/cm²)</i> | 0,46 | 0,47 | 0,46 |
| 3 | <i>Discharge Pressure (kgf/cm²)</i> | 17,13 | 16,87 | 16,87 |
| 4 | <i>Suction Temperature (°C)</i> | 46,08 | 46,66 | 48,41 |
| 5 | <i>Discharge Temperature (°C)</i> | 59,5 | 59,66 | 63 |
| 6 | <i>Flow (m³/hour)</i> | 4,23 | 4,26 | 4,25 |

4,2 Analisa Perhitungan Pompa Sirkulasi Minyak Sawit pada *Concentrated Solar Power*

Pada tahap analisa perhitungan menggunakan *sample* data pompa sirkulasi minyak sawit A pada *Concentrated Solar Power* ketika beroperasi pada bulan Desember 2015 dan beberapa data *design pompa sirkulasi minyak sawit*, untuk dilakukannya proses pemodelan perhitungan matematika guna mengetahui kinerja dari pompa sirkulasi minyak sawit pada *Concentrated Solar Power* yang berada di UPT BPPTK LIPI Yogyakarta,

Tabel 4.25 Data Pompa sirkulasi minyak sawit A

| No | Parameter | Pagi | Siang | Sore |
|----|---|---------|---------|---------|
| 1 | Speed (rpm) | 2880,33 | 2850,63 | 2888,16 |
| 2 | Suction Pressure (kgf/cm ²) | 0,56 | 0,49 | 0,54 |
| 3 | Discharge Pressure (kgf/cm ²) | 18,45 | 19,15 | 18,80 |
| 4 | Suction Temperature (°C) | 46,08 | 46,66 | 48,41 |
| 5 | Discharge Temperature (°C) | 59,5 | 59,66 | 63 |
| 6 | Flow (m ³ /hour) | 4,21 | 4,31 | 4,26 |

Tabel 4.26 Data desain pompa sirkulasi minyak sawit *Concentrated Solar Power*

| Parameter | Pompa Design |
|---------------------------|--------------|
| Speed (rpm) | 2900 |
| Head (m) | 15 |
| Flow (m ³ /hr) | 4,5 |
| Efficiency (%) | 75 |
| Power (KW) | 0,75 |
| Weight (kg) | 16 |

A. Head Tekanan :

➤ Head Kerugian Gesek untuk Pipa Lurus

$$\begin{aligned} h_f &= \frac{10,666 \times Q^{1,85}}{C^{1,85} \times D^{4,85}} \times L \\ &= \frac{10,666 \times 0,00171^{1,85}}{120^{1,85} \times 0,0254^{4,85}} \times 32 \\ &= 14,0198 \end{aligned}$$

➤ Kerugian pada satu belokan 90°

Menurut persamaan 2,19 (Sularso hal 34, 1996)

$$v = \frac{Q}{\frac{\pi}{4} D^2} = \frac{0,00171}{\frac{\pi}{4} 0,0254^2} = 2,3128 \text{ m/detik}$$

Dengan $D/R = 1$

$\theta = 90$, maka

$$\begin{aligned} f &= 0,131 + 1,847 \left(\frac{D}{2R} \right)^{3,5} \left(\frac{\theta}{90} \right)^{0,5} \\ &= 0,131 + 1,847 \left(\frac{0,0254}{2} \right)^{3,5} \left(\frac{90}{90} \right)^{0,5} \\ &= 0,1748 \end{aligned}$$

$$h_f = f \frac{v^2}{2g} = 0,1718 \frac{2,31^2}{2(9,8)} = 0,04 \text{ m}$$

➤ Kerugian pada katup isap dengan saringan

Dari tabel 2,20 (Sularso hal 39, 1996) untuk diameter pipa ≥ 100 mm diperoleh, $f = 1,97$, Maka

$$h_f = f \frac{v^2}{2g} = 1,97 \frac{2,31^2}{2(9,8)} = 0,53 \text{ m}$$

➤ Head Kecepatan Keluar

$$\frac{v_d^2}{2g} = \frac{2,3128^2}{2(9,8)} = 0,27 \text{ m}$$

➤ **Head Total Pompa**

$$\begin{aligned}
 H &= h_a + \Delta h_p + h_1 + \frac{v_d^2}{2g} \\
 &= 3 + 0 + 14,02 + (5 \times 0,04) + 0,53 + 0,27 \\
 &= 18,07 \text{ m}
 \end{aligned}$$

➤ **Hukum Kesebangunan :**

$$\begin{aligned}
 \bullet \quad Q_f &= Q_t \times \frac{n_d}{n_t} \\
 &= 0,00171 \text{ m}^3/\text{detik} \times \left(\frac{2900 \text{ rpm}}{2830,33 \text{ rpm}} \right) \\
 &= 0,0012 \text{ m}^3/\text{detik} \\
 &= 4,24 \text{ m}^3/\text{jam}
 \end{aligned}$$

$$\begin{aligned}
 \bullet \quad H_f &= H_t \times \left[\frac{n_d}{n_t} \right]^2 \\
 &= 18,06 \text{ m} \times \left[\frac{2900 \text{ rpm}}{2830,33 \text{ rpm}} \right]^2 \\
 &= 18,31 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 \bullet \quad Pdf &= \frac{Q_f}{Q_d} \times 100\% \\
 &= \frac{4,24 \text{ m}^3/\text{jam}}{4,5 \text{ m}^3/\text{jam}} \times 100\% \\
 &= 94,34 \%
 \end{aligned}$$

$$\begin{aligned}
 \bullet \quad \eta_t &= \eta_d \times pdf \\
 &= (0,75 \times 0,9434) \times 100\% \\
 &= 70,76 \%
 \end{aligned}$$

WHP (Water Horse Power)

$$\begin{aligned}
 \text{WHP} &= Q_f \times H \times \rho \times g \\
 &= 0,0012 \text{ m}^3/\text{detik} \times 18,07 \text{ m} \times 940 \text{ kg/m}^3 \times 9,8 \text{ m/s}^2 \\
 &= 196,29 \text{ W}
 \end{aligned}$$

BHP (Break horse Power)

$$\begin{aligned}
 \text{BHP} &= \frac{\text{WHP}}{n_t} \\
 &= \frac{196,29 \text{ W}}{0,71} \\
 &= 277,41 \text{ W}
 \end{aligned}$$

Efisiensi Pompa (η_p)

$$\begin{aligned}
 \eta_p &= \frac{\text{WHP}}{\text{BHP}} \times 100 \% \\
 &= \frac{196,29 \text{ W}}{277,41 \text{ W}} \times 100 \% \\
 &= 70,76 \%
 \end{aligned}$$

4,3 Hasil dan Analisa

Pada tabel 4.27 dan tabel 4.40 merupakan hasil perhitungan dari *head* pompa sirkulasi minyak sawit pada *Concentrated Solar Power* yang beroperasi selama tahun 2015,

Tabel 4.27 *Head* pompa sirkulasi minyak sawit A pada *Concentrated Solar Power* yang beroperasi selama tahun 2015,

| Bulan | Head pompa sirkulasi minyak sawit pada CSP (m) | | |
|-----------|--|-------|-------|
| | Pagi | Siang | Sore |
| Januari | 16,97 | 17,14 | 17,41 |
| Februari | 18,29 | 17,95 | 16,97 |
| Maret | 17,62 | 18,17 | 16,23 |
| April | 18,29 | 17,95 | 17,62 |
| Mei | 18,40 | 18,96 | 18,29 |
| Juni | 18,74 | 17,95 | 18,06 |
| Juli | 18,40 | 17,95 | 17,84 |
| Agustus | 17,95 | 17,84 | 17,73 |
| September | 18,29 | 18,85 | 18,17 |
| Oktober | 18,4 | 18,4 | 18,51 |
| November | 18,29 | 18,62 | 18,4 |
| Desember | 18,06 | 18,74 | 18,4 |

Tabel 4.28 *Head* pompa sirkulasi minyak sawit B pada *Concentrated Solar Power* yang beroperasi selama tahun 2015,

| Bulan | Head pompa sirkulasi minyak sawit pada CSP (m) | | |
|--------------|---|--------------|-------------|
| | Pagi | Siang | Sore |
| Januari | 20,10 | 21,71 | 20,49 |
| Februari | 19,19 | 21,03 | 20,10 |
| Maret | 21,84 | 19,97 | 21,84 |
| April | 20,76 | 20,63 | 22,26 |
| Mei | 21,98 | 22,68 | 21,71 |
| Juni | 21,57 | 21,71 | 20,63 |
| Juli | 22,26 | 20,63 | 21,03 |
| Agustus | 21,98 | 20,89 | 21,43 |
| September | 21,98 | 21,43 | 21,84 |
| Oktober | 22,12 | 21,84 | 21,98 |
| November | 22,54 | 22,12 | 21,84 |
| Desember | 21,71 | 21,98 | 21,84 |