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Vertical In - Line Process Pump
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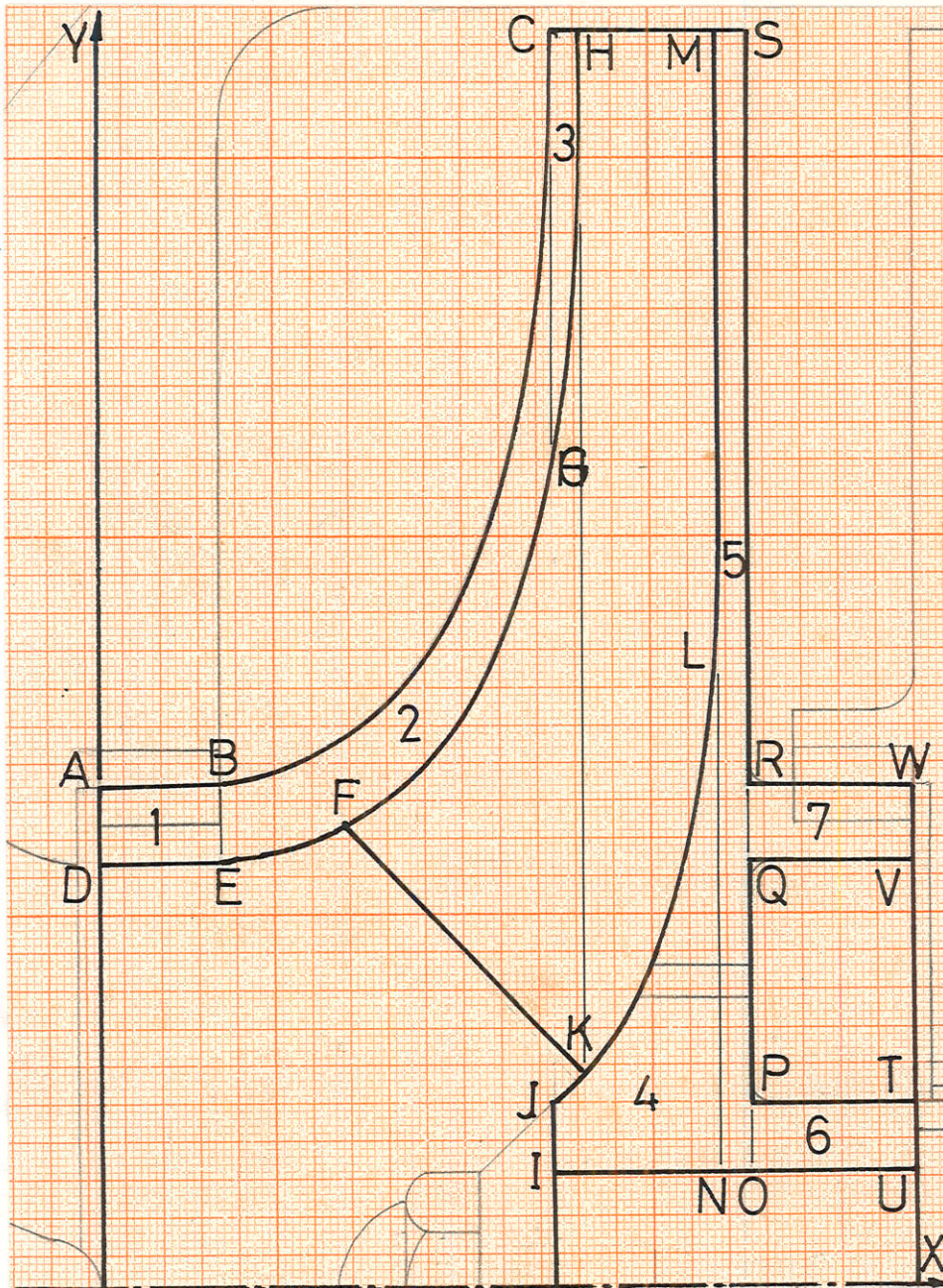
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LAMPIRAN



LAMPIRAN 1. PERHITUNGAN BERAT KOMPONEN BERPUTAR

PERHITUNGAN BERAT IMPELER





Daerah 1 (ABED) : x_1 (AD) = 0 y_1 (DE) = 57
 x_2 (EB) = 16 y_2 (AB) = 67

Daerah 2 (BCHE) : x_1 (EB) = 16 y_1 (EH) = $f(x)$
 x_2 (DB) = 60 y_2 (BC) = $f(x)$

Untuk mencari persamaan y_1 pada daerah 2 ini, diasumsikan kurva EH adalah parabola dengan puncak di titik E (16,57) dan melalui titik H (64,167).

Misalkan persamaan parabolanya

$$y = ax^2 + bx + c$$

Titik puncak parabola ada di absis $x = -b/2a$ dan ordinat $y = (b^2-4ac)/-4a$

Berarti $16 = -b/2a$ atau $32a + b = 0$ i

$57 = (b^2-4ac)/-4a$ atau

$228a - 4ac + b^2 = 0$ ii

Pada titik H (64,167) berlaku

$167 = a64^2 + b.64 + c$ atau

$4096a + 64b + c = 167$ iii

Substitusi persamaan i ke persamaan ii dan iii menghasilkan

$228a - 4ac + 1024a^2 = 0$ iv

dan

$2048a + c - 167 = 0$ v



$$228a - 4a (167 - 2048a) + 1024a^2 = 0$$

$$9216a^2 - 440a = 0$$

$$a = 440/9216$$

$$a = 0.0477$$

$$\begin{aligned} \text{----->} \quad c &= 167 - 2048a = 69,2222 \\ b &= -32a = -1,5278 \end{aligned}$$

Sehingga diperoleh persamaan parabola yang dimaksud :

$$y_1 = 0,0477x^2 - 1,5278x + 69,2222$$

Dara yang sama dengan di atas digunakan untuk mencari persamaan parabola BC. Puncak parabola di titik B (16,67) dan melalui titik C (60,167)

Pada puncak parabola :

$$16 = -b/2a \quad \text{atau} \quad 32a + b = 0 \quad \text{.....i}$$

dan

$$67 = (b^2 - 4ac) / -4a \quad \text{atau}$$

$$268a - 4ac + b^2 = 0 \quad \text{.....ii}$$

Di titik C (60,167) berlaku :

$$167 = a60^2 + b 60 + c \quad \text{atau}$$

$$3600a^2 + 60b + c = 0 \quad \text{.....iii}$$

Substitusi i ke ii dan iii menghasilkan

$$268a - 4ac + 1024a^2 = 0 \quad \text{.....iv}$$

dan

$$1680a + c - 167 = 0 \quad \text{.....v}$$

Substitusi persamaan v ke persamaan iv :

$$268a - 4a (167 - 1680a) + 1024a^2 = 0$$

$$7744a^2 - 400a = 0$$

$$a = 400/1696$$

$$a = 0,0517$$

$$\begin{aligned} \text{----->} \quad c &= 167 - 1680 \cdot 0,0517 = 80,2231 \\ b &= -32a = -1,6528 \end{aligned}$$



Penampang poros pompa, kopling, poros motor, sleeve, mehani cap screw dan tab wash adalah seperti gambar di bawah ini.

Untuk memudahkan perhitungan diasumsikan luas penampang meli bagian 0-1, 2-3 dan 4-5 sama yaitu

$$D1 := 32 \quad \text{mm}$$

Penampang 1-2 dan 6-7 pada sleeve

$$D2 := 50 \quad \text{mm}$$

Penampang kopling 3-4

$$D3 := 42 \quad \text{mm}$$

Panjang masing-masing penampang adalah :

$$LD1 := 75 + 10 + 32 \quad LD1 = 117$$

$$LD2 := 190 + 60 \quad LD2 = 250$$

$$LD3 := 200 \quad LD3 = 200$$

Dengan asumsi bahwa seluruh bagian benda adalah pejal dan te dari bahan yang sama yaitu 416 SS maka berat masing-masing b dapat dihitung. Massa jenis bahan poros adalah :

$$\rho_{\text{Poros}} := 7.695 \cdot 10^{-6} \quad \text{kg/mm}^3$$

Volume masing-masing bagian adalah :

$$VD1 := \frac{1}{4} \pi D1^2 \cdot LD1 \quad VD1 = 9.40$$



$$y_2 = 0,0517x^2 - 1,6529x + 80,2231$$

Daerah 3 (CGH) : x_1 (CG) = 60
 x_2 (H) = 64
 y_1 (GH) = $0,0517x^2 - 1,6529x + 80,2231$
 y_2 (CH) = 167

Daerah 4 (IJLN) : x_1 (IJ) = 60 y_1 (IN) = 16
 x_2 (LN) = 82 y_2 (JL) = $f(x)$

Dimisalkan y_2 (JL) parabola yang melalui titik-titik J (60,25), K(64,29) dan L(82,100). Bila $y_2 = ax^2 + bx + c$, maka pada

Titik J (60,25) : $25 = a 60^2 + b 60 + c$
 $3600a + 60b + c = 25$ i

Titik K (64,29) : $29 = a 64^2 + b 64 + c$
 $4096a + 64b + c = 29$ ii

Titik L (82,100) : $100 = a 82^2 + b 82 + c$
 $67824a + 82b + c = 100$ iii

Eliminasi i dan ii menghasilkan :

$$496a + 4b = 4$$
 iv

Eliminasi i dan iii menghasilkan :

$$3124a + 22b = 75$$
 v

Eliminasi iv dan v menghasilkan :

$$\begin{array}{r} 2728a + 22b = 22 \\ 3124a + 22b = 75 \\ \hline \end{array}$$

$$\begin{array}{r} 396a = 53 \\ a = 0,1338 \end{array}$$

-----> $b = 1 - 124 \cdot 0,1338 = -15,5960$
 Dari i, ii atau iii $c = 478,9394$

Sehingga :

$$y_2 = 0,1338x^2 - 15,5960x + 478,9394$$



Daerah 6 (OPUT) : $x1$ (OP) = 86 $x2$ (UT) = 108 $y1$ (QV) = 16 $y2$ (RW) = 25

Daerah 7 (QRWV) : $x1$ (QR) = 86 $x2$ (WV) = 108 $y1$ (QV) = 57 $y2$ (RW) = 67

Jumlah seluruh volume benda putar sama dengan volume shroud impeler. Integral volume benda putar masing-masing daerah di peroleh dengan rumus :

$x1 := 1$ $x2 := 2$ $y1 := 1$ $y2 := 1$

$$V_n := \int_{x1}^{x2} y2^2 - y1^2 dx$$

Daerah 1 :

$$V1 := \pi \int_0^{16} 67^2 - 57^2 dx$$

$$V1 = 6.23292 \cdot 10^4$$

Daerah 2 :

$$V2 := 3.48072 \cdot 10^5 \text{ mm}^3$$

Daerah 3 :

$$V3 := \int_{64}^{60} 167^2 \pi - [0.0517 \cdot x^2 - 1.6529 \cdot x + 80.223] dx$$

$$V3 = 4.15952 \cdot 10^4 \text{ mm}^3$$

Daerah 4 :

$$V4 := \int_{60}^{82} [0.1338 \cdot x^2 - 15.5960 \cdot x + 478.9394] \pi dx$$

$$V4 = 1.99562 \cdot 10^5 \text{ mm}^3$$



$$V5 := \int_{82}^{86} \pi \cdot [167^2 - 16^2] dx$$

$$V5 = 3.47247 \cdot 10^5 \text{ mm}^3$$

Daerah 6 :

$$V6 := \int_{86}^{108} \pi \cdot [25^2 - 16^2] dx$$

$$V6 = 2.55034 \cdot 10^4 \text{ mm}^3$$

Daerah 7 :

$$V7 := \int_{86}^{108} \pi \cdot [67^2 - 57^2] dx$$

$$V7 = 8.57026 \cdot 10^4 \text{ mm}^3$$

Volume 'shroud' impeler :

$$V_{\text{shroud}} := V1 + V2 + V3 + V4 + V5 + V6 + V7$$

$$V_{\text{shroud}} = 1.11001 \cdot 10^6 \text{ mm}^3$$

~~~~~ Menghitung Volume Sudu-sudu Impeler ~~~~~

Volume sebuah sudu ipeler dihitung dengan mengalikan luas da FHK dengan tebal sudu rata-rata (s). Daerah FHK dibagi men dua bagian FHK (A1) dan HKM (A2).

Daerah FHK dibatasi oleh :

$$\begin{aligned} x1 (F) &= 33 \\ x2 (HK) &= 64 \end{aligned}$$

$$\begin{aligned} y1 (FK) &= f(Q) \\ y2 (FH) &= 0,0477x^2 + 1,5278x + 6 \end{aligned}$$



Dengan tebal sudu rata-rata $s=0.1875$ in (4.7625 mm), volume buah sudu pada impeler adalah :

$$s := 4.7625 \quad \text{mm}$$

$$V_{\text{sudu}} := 8 \cdot A \cdot s$$

$$V_{\text{sudu}} = 1.97494 \cdot 10^5 \quad \text{mm}^3$$

Berat Total Impeler
 ~~~~~

Bila V adalah volume total impeler :

$$V := V_{\text{shroud}} + V_{\text{sudu}}$$

$$V = 1.30751 \cdot 10^6 \quad \text{mm}^3$$

Maka berat total impeler dihitung dengan persamaan :

$$W_i = \rho \cdot g \cdot V$$

Dimana  $\rho$  adalah massa jenis bahan impeler. Bahan impeler ada cor Gr. 25 (ASTM A48 Gr.25A)

$$\rho := 7.15 \cdot 10^{-6} \quad \text{kg/mm}^3$$

$$g := 9.81 \quad \text{m/s}^2$$

Berat Total Impeler :

$$W_i := \rho \cdot g \cdot V$$

$$W_i = 91.71038 \quad \text{newton}$$



$$VD2 := \frac{1}{4} \pi D2^2 \cdot LD2$$

$$VD2 = 4.90$$

$$VD3 := \frac{1}{4} \pi D3^2 \cdot LD3$$

$$VD3 = 2.77$$

Volume total poros dan bagian-bagiannya adalah :

$$VPoros := VD1 + VD2 + VD3$$

$$VPoros = 8.62059 \cdot 10^5 \quad \text{mm}^3$$

Berat seluruh bagian benda tersebut adalah :

$$WPoros := \rho_{Poros} \cdot g \cdot VPoros$$

$$WPoros = 85.07509 \quad \text{newton}$$

~~~~~  
Berat Total Komponen Yang Berputar
~~~~~

Berat total komponen yang berputar akan merupakan tambahan g aksial bagi pompa.

Berat total komponen-komponen yang berputar adalah :

$$W := W_{Impeler} + WPoros$$

$$W = 156.7855 \quad \text{newton}$$

Dalam satuan lbf berat totalnya adalah :

$$W := 0.2248 \cdot W$$

$$W = 35.24538 \quad \text{lbf}$$



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## LAMPIRAN 2. LEMBARAN DATA API PROCESS

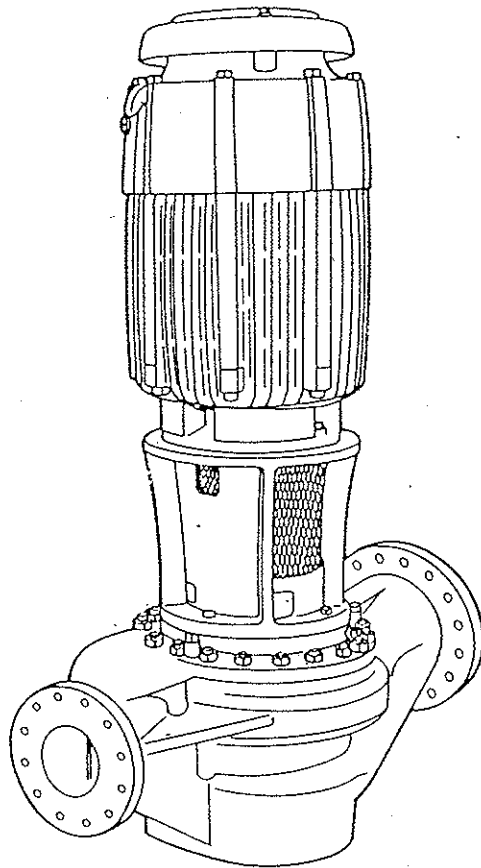
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# Type W



Flows to 5500 gpm (1250 m<sup>3</sup>/hr)

Heads to 725 feet (220 m)

Temperatures from -300°F to 750°F (-185°C to 400°C)

Pressures to 1200 psig (82 bar)



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## Materials Of Construction

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| Part                                | Non Corrosive    | Non Corrosive             | Mildly Corrosive | Corrosive    | Corrosive       | Corrosive       |
|-------------------------------------|------------------|---------------------------|------------------|--------------|-----------------|-----------------|
| Temperature ° F                     | -20° to 500°     | -20° to 500°              | -20° to 800°     | -20° to 800° | -20° to 750°    | -20° to 750°    |
| API 5th & 6th Edition Material Code | S1               | —                         | S6               | C6           | —               | A8              |
| Column                              | DR               | DR-1                      | H                | G            | SR-6            | SR-5            |
| Shell                               | Carbon Steel     |                           |                  | 12 Chrome    | Stainless Steel |                 |
| Impeller                            | C.I.             |                           | 12 Chrome        |              | Stainless Steel |                 |
| Impeller Part                       | C.I.             | 12 Chrome Hardened        |                  |              | Nitronic        | S.S. Hard Faced |
| <b>Materials</b>                    |                  |                           |                  |              |                 |                 |
| Impeller                            | Carbon Steel WCB |                           |                  | 12 Chrome    | 316L S.S.       |                 |
| Impeller                            | Cast Iron 25A    |                           | 12 Chrome        |              | 316L S.S.       |                 |
| Screw Impeller                      | 316 S.S.         |                           |                  |              |                 |                 |
| Impeller—Stuffing Box Wear Ring     | Cast Iron 30B    | 416 S.S. Hardened A       |                  |              | Nitronic 50     | 316L S.S.-HF    |
| Impeller Wear Rings & Back Hub      | Cast Iron 30B    | 416 (Mod) S.S. Hardened B |                  |              | Nitronic 60     | 316L S.S.-HF    |
|                                     |                  | 416 S.S.                  |                  |              | 316 S.S.        |                 |
| Sleeve (i. Seal)                    |                  | 416 S.S.                  |                  |              | 316 S.S.        |                 |
| Sleeve (ed Box)                     |                  | 416 S.S. Hardened A       |                  |              | 316L S.S.-HF    |                 |
| (i. Seal)                           |                  | Carbon Steel WCB          |                  | 316 S.S.     |                 |                 |
| Cage                                | Teflon           |                           |                  |              |                 |                 |
| Stuffing Box                        | 416 S.S.         |                           |                  |              | 316 S.S.        |                 |
| Stuffing Box (ision)                | Carbon Steel WCB |                           |                  | 12 Chrome    | 316L S.S.       |                 |
| Port                                | Cast Iron 30B    |                           |                  |              |                 |                 |
| Plate                               | Carbon Steel WCB |                           |                  |              |                 |                 |

## Material Specifications

| General Description | Specification               | General Description | Specification         |
|---------------------|-----------------------------|---------------------|-----------------------|
| Carbon Steel WCB    | ASTM A216 Gr. WCB           | Nitronic 60         | UNS S 21800           |
| Carbon Steel 4140   | ASTM A322 Gr. 4140          | Cast Iron 25A       | ASTM A48 Gr. 25A      |
| Carbon Steel 1020   | ASTM A322 Gr. 1020          | Cast Iron 30B       | ASTM A48 Gr. 30B      |
| 12 Chrome           | ASTM A743 Gr. CA-15         | 316L S.S.           | ASTM A351 Gr CF3M     |
| 416 S.S.            | ASTM A582 Type 416          | 316 S.S.            | ASTM A479 Type 316    |
| 416 S.S. Hardened A | ASTM A582 Type 416 Hardened | 316L S.S.-HF        | Colmonoy #6/ASTM A479 |
| 416 S.S. Hardened B | ASTM A473 Type 416 Hardened | Aluminum            | ASTM B26-74 Alloy 355 |
| Nitronic 50         | ASTM A351 CG6MMN            | Bronze              | ASTM B505 Gr. CA932   |



| Pump<br>Size | Shaft Data Diameter |                        |             | Stuffing Box Data |              |       |                                       | Casing Data           |       |      | API<br>Cir. |       |       |       |       |       |       |       |
|--------------|---------------------|------------------------|-------------|-------------------|--------------|-------|---------------------------------------|-----------------------|-------|------|-------------|-------|-------|-------|-------|-------|-------|-------|
|              | At<br>Imp.          | Under<br>Mech.<br>Seal | At<br>Cplg. | Shaft<br>O.D.     | Bore<br>I.D. | Depth | Dist.<br>From<br>Face to<br>1st Obst. | Auxiliary Connections |       |      |             |       |       |       |       |       |       |       |
|              |                     |                        |             |                   |              |       |                                       | Vent                  | Drain | Gage |             |       |       |       |       |       |       |       |
| V            | .938                | 1.375                  | 1.00        | 1.750             | 2.50         | 3.125 | 2.250                                 | .50                   | .75   | .50  | .017        |       |       |       |       |       |       |       |
| 7WL          |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| V            |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| VL           |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| VL           |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| VL           |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| 8W           |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| VL           |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| VLH          |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 2.63  | 1.75  | 2.31  |       |       |       |       |
| V            |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 2.50  | 3.125 | 2.250 |       |       |       |       |
| V            | 1.250               | 1.675                  | 1.250       | 1.750             | 2.750        | 3.440 | 2.690                                 | .50                   | .75   | .50  | .020        |       |       |       |       |       |       |       |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| 10W          |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             |       |       |       |       |       |       |       |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 1.625 | 2.00  | 1.625 | 2.375 | 3.375 | 4.563 | 2.750 |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 1.625 | 2.00  | 1.625 | 2.375 | 3.375 | 4.563 | 2.750 |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 1.625 | 2.00  | 1.625 | 2.50  | 3.56  | 4.563 | 5.50  |
| WH           |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 1.625 | 2.00  | 1.625 | 2.50  | 3.75  | 3.125 | 5.50  |
| W            |                     |                        |             |                   |              |       |                                       |                       |       |      |             | 2.00  | 2.375 | 2.00  | 3.063 | 4.125 | 4.563 | 5.940 |
| WH           | 2.00                | 2.375                  | 2.00        | 3.063             | 4.125        | 3.125 | 5.940                                 | 0.022                 |       |      |             |       |       |       |       |       |       |       |
| W            | 2.50                | 2.88                   | 2.50        | 3.38              | 4.44         | 4.81  | 5.00                                  | .75                   | .75   | .50  | .025        |       |       |       |       |       |       |       |

: All dimensions given in inches.



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Engineering Information  
 (Metric Units)

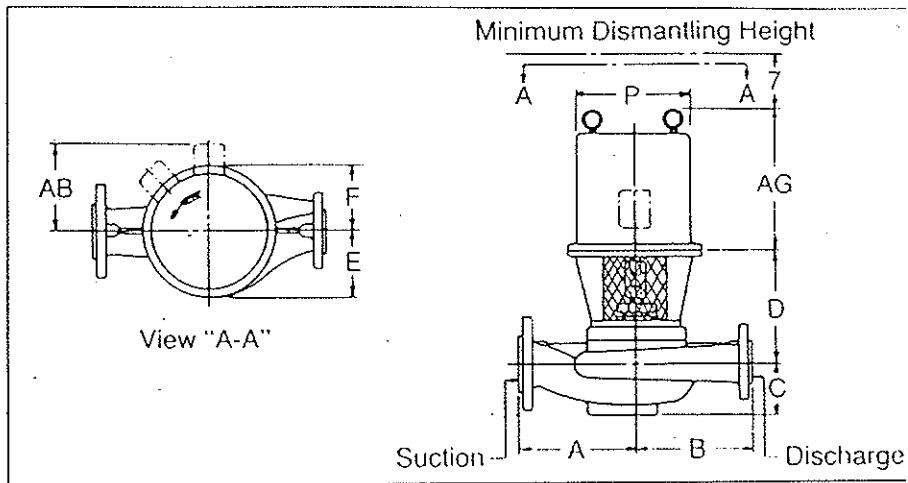
| Pump Size | Shaft Data |                  |          | Stuffing Box Data |           |       |                              | Casing Data           |       |      | API Cir. |
|-----------|------------|------------------|----------|-------------------|-----------|-------|------------------------------|-----------------------|-------|------|----------|
|           | Diameter   |                  |          | Shaft O.D.        | Bore I.D. | Depth | Dist. From Face to 1st Obst. | Auxiliary Connections |       |      |          |
|           | At Imp.    | Under Mech. Seal | At Cplg. |                   |           |       |                              | Vent                  | Drain | Gage |          |
| × 7W      | 23.8       | 34.9             | 25.4     | 44.5              | 63.5      | 79.4  | 57.2                         | 12.7                  | 19.1  | 12.7 | .432     |
| ½ × 7WL   |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 7W      |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 7WL     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 7WL     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8WL     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| ½ × 8W    |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8WL     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8WLH    |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8W      |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8W      | 31.8       | 41.3             | 31.8     | 44.5              | 69.9      | 87.4  | 68.3                         | 12.7                  | 19.1  | 12.7 | .508     |
| × 8W      |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8W      |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 8WL     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 9W      |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 10W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| ½ × 10W   |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 10W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 10W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 11W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 12W     | 41.3       | 50.8             | 41.3     | 60.3              | 85.7      | 115.9 | 69.9                         | 19.1                  | 19.1  | 12.7 | .635     |
| × 12W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 12W     | 41.3       | 50.8             | 41.3     | 60.3              | 85.7      | 115.9 | 69.9                         | 19.1                  | 19.1  | 12.7 | .635     |
| × 15W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 15WH    |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 18W     |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 18WH    |            |                  |          |                   |           |       |                              |                       |       |      |          |
| × 20W     |            |                  |          |                   |           |       |                              |                       |       |      |          |

Notes: All dimensions given in millimeters.



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## Dimensions And Weights (English Units)



Approximate Dimensions—Do not use for construction(1)

| Pump   | Suct. | Disch. | A     | B     | C     | D     | E     | F     | P     | AB    | AG    | Unit Wt.(2) |
|--------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------------|
| 1x7W   | 2.0   | 1.0    | 9.00  | 9.00  | 4.00  | 16.75 | 5.75  | 4.75  | 15.12 | 12.38 | 26.88 | 44          |
| 1½x7WL | 3.0   | 1.5    | 10.00 | 10.00 | 4.75  | 16.75 | 6.00  | 6.00  | 15.12 | 12.38 | 26.88 | 59          |
| 3x7W   | 4.0   | 3.0    | 11.00 | 11.00 | 5.25  | 16.88 | 6.00  | 6.00  | 17.38 | 14.12 | 30.62 | 70          |
| 3x7WL  | 4.0   | 3.0    | 12.00 | 12.00 | 5.50  | 17.00 | 6.50  | 5.75  | 19.62 | 15.12 | 34.38 | 84          |
| 4x7WL  | 6.0   | 4.0    | 15.00 | 15.00 | 6.75  | 17.12 | 10.00 | 6.25  | 19.62 | 16.25 | 34.38 | 116         |
| 1x8WL  | 3.0   | 1.0    | 10.50 | 10.50 | 4.75  | 16.75 | 6.00  | 6.00  | 15.12 | 12.38 | 26.88 | 59          |
| 1½x8W  | 3.0   | 1.5    | 10.50 | 10.50 | 5.00  | 16.75 | 6.00  | 6.00  | 17.38 | 14.12 | 30.62 | 67          |
| 2x8WL  | 4.0   | 2.0    | 11.50 | 11.50 | 5.50  | 16.88 | 6.25  | 5.75  | 19.62 | 15.12 | 34.38 | 81          |
| 2x8WLH | 4.0   | 2.0    | 12.50 | 12.50 | 6.00  | 17.19 | 6.50  | 6.00  | 19.62 | 15.38 | 34.38 | 86          |
| 3x8W   | 4.0   | 3.0    | 12.00 | 12.00 | 5.75  | 16.88 | 6.75  | 6.00  | 23.25 | 19.62 | 41.75 | 103         |
| 4x8W   | 6.0   | 4.0    | 15.00 | 15.00 | 6.75  | 17.00 | 9.75  | 6.50  | 23.88 | 19.62 | 41.75 | 147         |
| 4x8WL  | 6.0   | 4.0    | 15.00 | 15.00 | 7.00  | 17.12 | 9.75  | 7.50  | 23.88 | 19.62 | 41.75 | 172         |
| 4x9W   | 6.0   | 4.0    | 16.50 | 16.50 | 7.50  | 18.00 | 10.38 | 7.31  | 23.88 | 19.62 | 41.75 | 218         |
| 1x10W  | 3.0   | 1.0    | 12.00 | 12.00 | 4.50  | 17.50 | 7.25  | 7.25  | 19.62 | 15.12 | 34.38 | 79          |
| 1½x10W | 3.0   | 1.5    | 12.00 | 12.00 | 5.00  | 17.50 | 6.50  | 6.25  | 23.25 | 19.62 | 41.75 | 104         |
| 3x10W  | 6.0   | 3.0    | 14.50 | 14.50 | 6.50  | 17.62 | 7.50  | 6.75  | 23.88 | 19.62 | 41.75 | 160         |
| 4x10W  | 6.0   | 4.0    | 16.50 | 16.50 | 7.75  | 17.75 | 10.00 | 7.00  | 23.88 | 19.62 | 41.75 | 214         |
| 4x11W  | 6.0   | 4.0    | 17.50 | 17.50 | 8.00  | 20.69 | 11.12 | 8.12  | 23.88 | 19.62 | 41.75 | 296         |
| 2x12W  | 4.0   | 2.0    | 15.00 | 15.00 | 6.00  | 20.44 | 8.75  | 8.75  | 23.88 | 19.62 | 41.75 | 226         |
| 3x12W  | 6.0   | 3.0    | 16.00 | 16.00 | 7.25  | 20.47 | 8.88  | 8.75  | 23.88 | 19.62 | 41.75 | 273         |
| 4x12W  | 6.0   | 4.0    | 18.00 | 18.00 | 8.00  | 20.50 | 11.12 | 8.75  | 23.88 | 19.62 | 41.75 | 287         |
| 6x15W  | 8.0   | 6.0    | 27.00 | 25.00 | 12.00 | 22.50 | 15.00 | 10.50 | 23.88 | 19.62 | 41.75 | 304         |
| 6x15WH | 8.0   | 6.0    | 27.00 | 25.00 | 12.00 | 22.50 | 15.25 | 11.00 | 23.88 | 19.62 | 41.75 | 325         |
| 6x18W  | 10.0  | 6.0    | 30.00 | 28.00 | 14.62 | 23.94 | 17.00 | 12.38 | 26.75 | 21.38 | 63.75 | 447         |
| 6x18WH | 10.0  | 6.0    | 30.00 | 28.00 | 14.62 | 23.94 | 17.38 | 12.36 | 26.75 | 21.38 | 63.75 | 495         |
| 8x20W  | 14.0  | 8.0    | 36.00 | 34.00 | 17.25 | 25.00 | 19.88 | 14.62 | 34.75 | 22.06 | 75.88 | 540         |

Footnotes: (1) All dimensions given in inches, weight in pounds.  
 (2) Unit weight includes pump and average size motor.

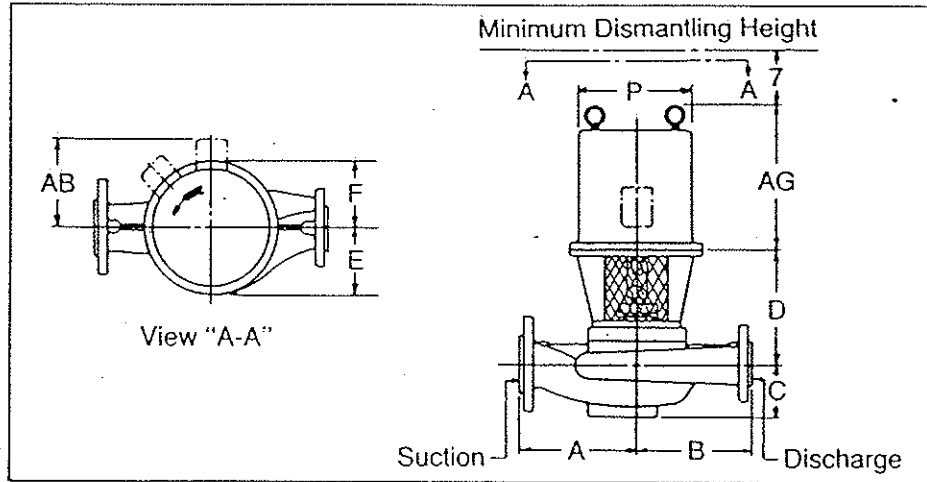


Vertical In - Line Process Pump

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Dimensions And Weights  
(Metric Units)



Approximate Dimensions—Do not use for construction(1)

| Pump  | Suct. (in.) | Disch. (in.) | A   | B   | C   | D   | E   | F   | P   | AB  | AG   | Unit Wt.(2) |
|-------|-------------|--------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-------------|
| 7W    | 2.0         | 1.0          | 229 | 229 | 102 | 425 | 146 | 121 | 384 | 315 | 683  | 202         |
| × 7WL | 3.0         | 1.5          | 254 | 254 | 121 | 425 | 153 | 153 | 384 | 315 | 683  | 268         |
| 7W    | 4.0         | 3.0          | 279 | 279 | 133 | 429 | 153 | 153 | 442 | 359 | 778  | 318         |
| 7WL   | 4.0         | 3.0          | 305 | 305 | 140 | 432 | 165 | 146 | 498 | 384 | 873  | 381         |
| 7WL   | 6.0         | 4.0          | 381 | 381 | 172 | 435 | 254 | 159 | 498 | 413 | 873  | 528         |
| 8WL   | 3.0         | 1.0          | 267 | 267 | 121 | 425 | 153 | 153 | 384 | 315 | 683  | 268         |
| × 8W  | 3.0         | 1.5          | 267 | 267 | 127 | 425 | 153 | 153 | 442 | 359 | 778  | 306         |
| 8WL   | 4.0         | 2.0          | 292 | 292 | 140 | 429 | 159 | 146 | 498 | 384 | 873  | 367         |
| 8WLH  | 4.0         | 2.0          | 318 | 318 | 153 | 437 | 165 | 153 | 498 | 391 | 873  | 390         |
| 8W    | 4.0         | 3.0          | 305 | 305 | 146 | 429 | 172 | 153 | 591 | 498 | 1061 | 467         |
| 8W    | 6.0         | 4.0          | 381 | 381 | 172 | 432 | 248 | 165 | 606 | 498 | 1061 | 669         |
| 8WL   | 6.0         | 4.0          | 381 | 381 | 178 | 435 | 248 | 191 | 606 | 498 | 1061 | 782         |
| 9W    | 6.0         | 4.0          | 419 | 419 | 191 | 457 | 264 | 186 | 606 | 498 | 1061 | 989         |
| 10W   | 3.0         | 1.0          | 305 | 305 | 114 | 445 | 184 | 184 | 498 | 384 | 873  | 358         |
| × 10W | 3.0         | 1.5          | 305 | 305 | 127 | 445 | 165 | 159 | 591 | 498 | 1061 | 472         |
| 10W   | 6.0         | 3.0          | 368 | 368 | 165 | 448 | 191 | 172 | 606 | 498 | 1061 | 726         |
| 10W   | 6.0         | 4.0          | 419 | 419 | 197 | 451 | 254 | 178 | 606 | 498 | 1061 | 971         |
| 11W   | 6.0         | 4.0          | 445 | 445 | 203 | 526 | 282 | 206 | 606 | 498 | 1061 | 1343        |
| 12W   | 4.0         | 2.0          | 381 | 381 | 153 | 519 | 222 | 222 | 606 | 498 | 1061 | 1027        |
| 12W   | 6.0         | 3.0          | 406 | 406 | 184 | 520 | 225 | 222 | 606 | 498 | 1061 | 1238        |
| 12W   | 6.0         | 4.0          | 457 | 457 | 203 | 521 | 282 | 222 | 606 | 498 | 1061 | 1305        |
| 15W   | 8.0         | 6.0          | 686 | 635 | 305 | 572 | 381 | 267 | 606 | 498 | 1061 | 1379        |
| 15WH  | 8.0         | 6.0          | 686 | 635 | 305 | 572 | 387 | 279 | 606 | 498 | 1061 | 1474        |
| 18W   | 10.0        | 6.0          | 762 | 711 | 371 | 608 | 432 | 315 | 680 | 543 | 1619 | 2030        |
| 18WH  | 10.0        | 6.0          | 762 | 711 | 371 | 608 | 442 | 315 | 680 | 543 | 1619 | 2245        |
| 20W   | 14.0        | 8.0          | 914 | 837 | 438 | 635 | 505 | 371 | 883 | 560 | 1927 | 2449        |

Notes: (1) All dimensions given in millimeters (except nozzle size, which is in inches), weight in kilograms.  
(2) Unit weight includes pump and average size motor.



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LAMPIRAN 3. KONVERSI SATUAN

# HYDRAULIC INSTITUTE PREFERRED MEASUREMENT UNITS AND CONVERSION FACTORS



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**metric conversion**

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| Quantity (1)                             | Typical Applications                                    | U.S. Customary Unit     | Abbrev. or Unit Symbol | Metric Unit                       | Symbol            | Conversion Factors U.S. to Metric | Metric to U.S. |
|------------------------------------------|---------------------------------------------------------|-------------------------|------------------------|-----------------------------------|-------------------|-----------------------------------|----------------|
| <b>1. Space and Time</b>                 |                                                         |                         |                        |                                   |                   |                                   |                |
| plane angle                              |                                                         | degree, minute, second  | ° ' "                  | degree (decimalized)              | °                 |                                   |                |
| length                                   | dimensions of sumps and pits                            | foot (and inch)         | ft or ' / in or "      | meter                             | m                 | 0.3048*                           | 3.281          |
|                                          |                                                         | inch                    | in or "                | millimeter                        | mm                | 0.0254*                           | 1/0.0254*      |
| area                                     | mechanical engineering drawings                         | square foot             | ft <sup>2</sup>        | square meter                      | m <sup>2</sup>    | 0.092 90                          | 10.76          |
|                                          |                                                         | square inch             | in <sup>2</sup>        | square millimeter                 | mm <sup>2</sup>   | 645.2                             | 0.001 550      |
|                                          |                                                         | mil                     | mil                    | micrometer                        | μm                | 25.4*                             | 1/25.4*        |
| volume                                   | coating thickness, surface finish, filter particle size | microinch               | μin                    | micrometer                        | μm                | 0.0254*                           | 1/0.0254*      |
|                                          |                                                         | micron                  | μm                     | micrometer                        | μm                | 1*                                | 1*             |
|                                          |                                                         | square foot             | ft <sup>2</sup>        | square meter                      | m <sup>2</sup>    | 0.092 90                          | 10.76          |
| fluid volume capacity                    | surface area, flow area                                 | square inch             | in <sup>2</sup>        | square millimeter                 | mm <sup>2</sup>   | 645.2                             | 0.001 550      |
|                                          |                                                         | cubic inch              | in <sup>3</sup>        | milliliter [cm <sup>3</sup> ] (2) | mL (3)            | 16.39                             | 0.061 02       |
|                                          |                                                         | cubic foot              | ft <sup>3</sup>        | cubic meter                       | m <sup>3</sup>    | 0.028 32                          | 35.31          |
| gallon                                   | fluid volume capacity                                   | gallon                  | gal                    | cubic meter                       | m <sup>3</sup>    | 0.003785                          | 264.2          |
|                                          |                                                         | quart                   | qt                     | liter                             | L                 | 0.9464                            | 1.057          |
| time                                     |                                                         | hour                    | h                      | hour                              | h                 | 1*                                | 1*             |
|                                          |                                                         | minute                  | min                    | min                               | min               | 1*                                | 1*             |
|                                          |                                                         | second                  | s                      | s                                 | s                 | 1*                                | 1*             |
| volume per unit time                     | flow rate of fluids                                     | gallon per minute       | gpm                    | cubic meter per hour              | m <sup>3</sup> /h | 0.2271                            | 4.403          |
|                                          |                                                         | gallon per minute       | gpm                    | liter per minute                  | L/min             | 3.785                             | 0.2642         |
| velocity, linear                         | fluid velocity                                          | foot per minute         | fpm                    | meter per second                  | m/s               | 0.005 08*                         | 196.9          |
|                                          |                                                         | foot per second         | fps                    | meter per second                  | m/s               | 0.3048*                           | 3.281          |
| acceleration                             |                                                         | foot per second-squared | ft/s <sup>2</sup>      | meter per second-squared          | m/s <sup>2</sup>  | 0.3048*                           | 3.281          |
| <b>2. Periodic and Related Phenomena</b> |                                                         |                         |                        |                                   |                   |                                   |                |
| frequency                                | system vibration, sound, alternating current            | cycle per second        | c/s                    | hertz                             | Hz                | 1*                                | 1*             |
| speed of rotation                        |                                                         | revolution per minute   | rpm                    | revolution per minute             | r/min             | 1*                                | 1*             |

\*Exact  
(1) As used in ISO-31 and ISO-1000, "quantity" means "measurable property".  
(2) Symbols in brackets, ( ), are explanatory only.  
National Bureau of Standards has established the capital letter "H" as the preferred unit symbol for hertz for the U. S.



| Quantity                                   | Typical Applications                                                   | U.S. Customary Unit                                | Abbrev. or Unit Symbol                                | Metric Unit                                                     | U.S. to Metric | Conversion Factors Metric to U.S. |
|--------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------------------|----------------|-----------------------------------|
| <b>3. Mechanics</b>                        |                                                                        |                                                    |                                                       |                                                                 |                |                                   |
| mass                                       | equipment mass (weight)                                                | pound (decimalized; do not use ounces with pounds) | lb or #                                               | kilogram                                                        | 0.4536         | 2.205                             |
|                                            |                                                                        | ounce                                              | oz                                                    | gram                                                            | 28.35          | 0.035 27                          |
| unbalance                                  | impeller, rotor                                                        | ounce-inch                                         | oz-in                                                 | gram-millimeter                                                 | 720.1          | 0.001 389                         |
| density (mass density)                     | density of solids and fluids                                           | pound per cubic foot                               | lb/ft <sup>3</sup>                                    | kilogram per cubic meter                                        | 16.02          | 0.062 43                          |
| specific weight (force)                    | solids and fluids                                                      | pound force per cubic foot                         | lb/ft <sup>3</sup>                                    | kilonewton per cubic meter                                      | 0.1571         | 6.366                             |
| moment of inertia (dynamic)                | rotor inertia                                                          | pound foot-squared                                 | lb·ft <sup>2</sup>                                    | kilogram meter-squared                                          | 0.042 14       | 23.73                             |
| force                                      | rotor inertia                                                          | pound-force (decimalized; do not use ounces)       | lbf                                                   | newton                                                          | 4.448          | 0.2248                            |
| fluid energy                               | head of fluid                                                          | foot                                               | ft                                                    | meter                                                           | 0.3048*        | 3.281                             |
| moment of force, torque and bending moment | bolt tightening, shaft torque, beam stress and deflection calculations | pound-force foot                                   | lbf·ft                                                | newton-meter                                                    | 1.356          | 0.7376                            |
|                                            |                                                                        | pound-force inch                                   | lbf·in                                                | newton-meter                                                    | 0.1130         | 8.851                             |
| pressure                                   | fluid pressure or vacuum (NPSH)                                        | pound-force per square inch [psi]                  | lbf/in <sup>2</sup>                                   | kilopascal [kN/m <sup>2</sup> ]                                 | 6.895          | 0.1450                            |
|                                            |                                                                        | inch of mercury [60F]                              | inHg                                                  | kilopascal                                                      | 3.377          | 0.2961                            |
| sound pressure level reference (1)         | sound pressure level reference (1)                                     | inch of water [60F]                                | inH <sub>2</sub> O                                    | kilopascal                                                      | 0.2488         | 4.019                             |
|                                            |                                                                        | microbar [0.0002 μbar]                             | μbar                                                  | micropascal [20 μPa]                                            | 100 000        | 0.000 01                          |
| stress                                     |                                                                        | pound-force per square inch [psi]                  | lbf/in <sup>2</sup>                                   | megapascal [MN/m <sup>2</sup> ] [N/mm <sup>2</sup> ]            | 0.006 895      | 145.0                             |
| specific speed                             | centrifugal pump impeller                                              | $\left[ \frac{N\sqrt{Q}}{(h)^{3/4}} \right]$       | $\frac{\text{rpm}\sqrt{\text{gpm}}}{\text{ft}^{3/4}}$ | $\frac{r/\text{min}\sqrt{\text{m}^3/\text{h}}}{\text{m}^{3/4}}$ | 1.162          | 0.8608                            |

\*Exact  
 (1) The unit for sound level will continue to be the decibel (dB), and will continue to have the same value because 20 μPa = 0.0002 μbar.  
 (2) Except in very weak materials (for which kPa may be more convenient), or for modulus of elasticity (for which GPa will usually be more convenient).

**HYDRAULIC INSTITUTE  
PREFERRED MEASUREMENT UNITS AND CONVERSION FACTORS**



Vertical In - Line Process Pump  
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**hydraulic institute  
metric conversion**

| Quantity                                     | Typical Applications                        | U.S. Customary Unit                          |                                                       | Abbrev. or Unit Symbol               |                           | Metric Unit                                                           | Symbol                | Conversion Factors        |                           |
|----------------------------------------------|---------------------------------------------|----------------------------------------------|-------------------------------------------------------|--------------------------------------|---------------------------|-----------------------------------------------------------------------|-----------------------|---------------------------|---------------------------|
|                                              |                                             | Unit                                         | Symbol                                                | Unit                                 | Symbol                    |                                                                       |                       | U.S. to Metric            | Metric to U.S.            |
| specific speed                               | centrifugal pump<br>impeller                | $\left[ \frac{N\sqrt{Q}}{(h)^{3/4}} \right]$ | $\frac{\text{rpm}\sqrt{\text{gpm}}}{\text{ft}^{3/4}}$ | centipascal-second                   | mPa·s                     | $\left[ \frac{\text{I.S.O.}}{2\pi N\sqrt{Q}} \right]$<br>$(gh)^{3/4}$ | unitless<br>(radians) | 0.000 3656                | 2735                      |
| viscosity, dynamic                           |                                             | centipoise                                   | cP                                                    | millipascal-second                   | mPa·s                     |                                                                       |                       | 1*                        | 1*                        |
| viscosity, kinematic                         |                                             | centistokes (1)                              | cSt                                                   | square-millimeter per second         | mm <sup>2</sup> /s        |                                                                       |                       | 1*                        | 1*                        |
| energy, work (see also heat and electricity) |                                             | foot pound-force                             | ft·lbf                                                | joule [N·m] (2)                      | J                         |                                                                       |                       | 1.356                     | 0.7376                    |
| power (see also heat and electricity)        |                                             | horsepower (550 ft·lbf/s)                    | hp                                                    | kilowatt [kJ/s] (2)                  | kW                        |                                                                       |                       | 0.7457                    | 1.341                     |
| 4. Heat                                      | temperature                                 | degree Fahrenheit                            | °F                                                    | degree Celsius (3)                   | °C                        |                                                                       |                       | $(t_f - 32) \times 5/9^*$ | $(t_c \times 1.8) + 32^*$ |
|                                              |                                             | interval between two temperatures            | °F                                                    | kelvin ( $\Delta t_k = \Delta t_c$ ) | K                         |                                                                       |                       | 5/9*                      | 1.8*                      |
| heat (energy)                                |                                             | British thermal unit                         | Btu (4)                                               | kilojoule                            | kJ                        |                                                                       |                       | 1.055                     | 0.9478                    |
| heat flow rate (power)                       | heat rejection rate, air conditioning power | British thermal unit per minute              | Btu/min                                               | watt [(J/s)] (2)                     | W                         |                                                                       |                       | 17.58                     | 0.05687                   |
| 5. Electricity                               | electric current                            | ampere                                       | A                                                     | ampere                               | A                         |                                                                       |                       | 1*                        | 1*                        |
|                                              | electromotive force                         | volt                                         | V                                                     | volt                                 | V                         |                                                                       |                       | 1*                        | 1*                        |
|                                              | electric resistance                         | resistors, conductors                        | ohm                                                   | ohm                                  | Ω                         |                                                                       |                       | 1*                        | 1*                        |
|                                              | conductance                                 | conductors                                   | mho                                                   | siemens                              | S                         |                                                                       |                       | 1*                        | 1*                        |
|                                              | energy                                      |                                              | kilowatt-hour                                         | kW·h                                 | kilowatt-hour (5)         | kW·h                                                                  |                       | 1*                        | 1*                        |
|                                              | power                                       | motors                                       | kilowatt                                              | kW                                   | kilowatt [kJ/s] or [kV·A] | kW                                                                    |                       | 1*                        | 1*                        |

\* Exact  
 (1) Conversion from Saybolt Universal Seconds to centistokes can be done from a table.  
 (2) By using J instead of N·m, the distinction from N·m for moment of force is made apparent.  
 (3) Conversion requires a formula, wherein the Fahrenheit temperature is indicated by  $t_f$ , and the Celsius temperature by  $t_c$ .  
 (4) All factors in this table are based on 8tu-International Table.



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LAMPIRAN 4. PEMILIHAN BAHAN POMPA MENURUT API STANDARD 610

Table F-1—Material Classes for Centrifugal Pumps



## CAUTIC Vertical In-Line Process Pump

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| UNIVERSITAS<br>GADJAH MADA<br>Service                                                                                                                                 | On-Plot<br>Process<br>Plant | Off-Plot<br>Transfer<br>and Loading | Temperature<br>Range (F) | Pressure<br>Range<br>(psig) | Material<br>Class | Note<br>Reference<br>Number |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------|--------------------------|-----------------------------|-------------------|-----------------------------|
| Fresh water, condensate,<br>cooling tower water                                                                                                                       | X                           | X                                   | <212                     | All                         | I-1 or I-2        |                             |
| Boiling water and process<br>water                                                                                                                                    | X                           | X                                   | <250                     | All                         | I-1 or I-2        | 7                           |
|                                                                                                                                                                       | X                           | X                                   | 250–350                  | All                         | S-5               | 7                           |
|                                                                                                                                                                       | X                           | X                                   | >350                     | All                         | D-6               | 7                           |
| Boiler feedwater                                                                                                                                                      |                             |                                     |                          |                             |                   |                             |
| Cast horizontally split                                                                                                                                               | X                           | X                                   | >200                     | All                         | C-6               |                             |
| Forged barrel                                                                                                                                                         | X                           | X                                   | >200                     | All                         | S-6               |                             |
| Boiler circulator                                                                                                                                                     | X                           | X                                   | >200                     | All                         | C-6               |                             |
| Foul water, reflux drum water,<br>water draw, and hydrocarbons<br>containing these waters,<br>including reflux streams                                                | X                           | X                                   | <350                     | All                         | S-3               | 2                           |
| Propane, butane, liquefied<br>petroleum gas, and ammonia<br>(NH <sub>3</sub> )                                                                                        | X                           | X                                   | <450                     | All                         | S-1               |                             |
| Diesel oil; gasoline;<br>naphtha; kerosine; gas oils;<br>light, medium, and heavy<br>lube oils; fuel oil; residuum;<br>crude oil; asphalt; synthetic<br>crude bottoms | X                           | X                                   | <450                     | All                         | S-1               |                             |
|                                                                                                                                                                       | X                           | X                                   | 450–700                  | All                         | S-6               | 2,5                         |
|                                                                                                                                                                       | X                           | X                                   | >700                     | All                         | C-6               | 2                           |
| Noncorrosive hydrocarbons,<br>e.g., catalytic reformat,<br>isomaxate, desulfurized oils                                                                               | X                           | X                                   | 450–700                  | All                         | S-4               | 5                           |
| Xylene, toluene, acetone,<br>benzene, furfural, MEK,<br>cumene                                                                                                        | X                           | X                                   | <450                     | All                         | S-1               |                             |
| Sodium carbonate, doctor<br>solution                                                                                                                                  | X                           | X                                   | <350                     | All                         | I-1               |                             |
| Caustic (sodium hydroxide)<br>concentration of 20% or less                                                                                                            | X                           | X                                   | <140                     | All                         | S-1               | 8                           |
|                                                                                                                                                                       | X                           | X                                   | 140–200                  | All                         | S-3               | 8                           |
|                                                                                                                                                                       | X                           | X                                   | >200                     | All                         |                   | 6                           |
| MEA, DEA, TEA—stock solutions                                                                                                                                         | X                           | X                                   | <250                     | All                         | S-1               |                             |
| DEA, TEA—lean solutions                                                                                                                                               | X                           | X                                   | <250                     | All                         | S-1               |                             |
| MEA—lean solution (CO <sub>2</sub> only)                                                                                                                              | X                           | X                                   | 175–300                  | All                         | S-9               |                             |
| MEA—lean solution (CO <sub>2</sub> and<br>H <sub>2</sub> S)                                                                                                           | X                           | X                                   | 175–300                  | All                         |                   | 9                           |
| MEA, DEA, TEA—rich solutions                                                                                                                                          | X                           | X                                   | <175                     | All                         | S-1               |                             |
| Sulfuric acid concentration                                                                                                                                           |                             |                                     |                          |                             |                   |                             |
| 85%                                                                                                                                                                   | X                           | X                                   | <100                     | All                         | S-1               | 2                           |
| 85%–15%                                                                                                                                                               | X                           | X                                   | <100                     | All                         | A-8               | 2                           |
| 15%–1%                                                                                                                                                                | X                           | X                                   | <100                     | All                         | A-8               | 2                           |
| 1%                                                                                                                                                                    | X                           | X                                   | <450                     | All                         | A-8               | 2                           |
| Hydrofluoric acid<br>concentration of over 96%                                                                                                                        | X                           | X                                   | <160                     | All                         | S-9               | 2                           |

## NOTES:

- The materials for pump parts for each material class are given in Appendix E.
- The corrosiveness of foul waters, hydrocarbons over 450 F, acids, and acid sludges may vary widely. A materials recommendation should be obtained for each service. The material class indicated above will be satisfactory for many of these services but must be verified.
- Cast iron cases, where recommended for chemical services, are for nonhazardous locations only. Use steel cases (S-1 or I-1) for pumps in services located near process plants or in any location where released vapor from a failure could create a hazardous situation or where pumps could be subjected to hydraulic shock, for example, in loading service.
- Obtain separate materials recommendations for services not clearly identified by the service descriptions listed in this table.
- If product corrosivity is low, Class S-4 materials may be used for services at 451–700 F. Obtain a separate materials recommendation in each instance.
- Use Alloy 20 or Monel pump material and double mechanical seals with a pressurized seal oil system.
- Consider oxygen content and buffering of water in the selection of material.
- All welds should be stress relieved.
- Use Class A-7 materials except for a carbon steel case.
- Mechanical seal materials: For streams containing chlorides, all springs and other metal parts should be Alloy 20 or better. Buna-N and neoprene should not be used in any service containing aromatics. Viton should not be used in services containing aromatics above 200 F.