Selecting a Positive Displacement Pump Using Performance Curves

Choosing a Pump Series

A. Gather all application information including product nature, viscosity, temperature, NIPA, flow rate and pressure loss.

B. Decide what series pump to use, FLII or FKL. For simple applications the more economical FLII pump will work, when the duty exceeds the capabilities of this pump the FKL should be applied.

The FKL and FL II Product Lines – Better Choices for Better Performance

To best match the broad range of positive displacement pump applications Fristam provides two product lines, the FKL and the FL II. While sharing many similarities the pumps are fundamentally different in design.

The FKL is a circumferential piston pump, meaning that its rotors run in a channel described by the pump housing and built-in internal hubs. The purpose of this design is to achieve high performance by maintaining tighter clearances and restricting product slip within the pump. The design produces higher pressures, the ability to self-prime and the capability of handling more difficult products and applications.

The FL II is a rotary lobe pump. Rotary lobes use the movement of two lobes in a pumping chamber to accomplish the pumping action. This style of pump is designed for standard duty applications.

Choosing Between the FKL or FL II

The FKL can be selected for any application within the capabilities of it or the FL II. Within its range, the FL II will often be a more attractive selection because of its economy and simplicity. The FL II should be considered for applications within the following parameters.

- Pressures to 170 psi
- Viscosities to 50,000 cps
- Flooded suction with at least 7 psia available
- Mechanical seals required
- 316L stainless steel rotors required
- Product is low to moderately shear sensitive

Selecting a Pump Size

Use the composite curves to make your initial pump selection.

1. Locate the product viscosity on the horizontal axis (1).
2. Locate the required flow rate on the vertical axis (2).
3. Determine the intersection between the flow rate and product viscosity (3).
4. Select a pump model above the intersection (3).

When selecting, keep in mind that it is best to run a positive displacement pump at no more than 400 to 500 rpm. The lower speeds reduce seal wear, extend pump life, reduce suction pressure requirements and produce quieter operation. The composite curves are based on the maximum speed of the pumps; therefore, the model selected will usually be one or two above the duty point.

For example: For a flow rate of 50 gpm and a product with a viscosity of 200 cps, the model directly above the duty point is a FLII 75L. However, if we look at the individual curve (page 37) for this pump we will see that it would have to run above the desired speed range. Therefore, we will select a FLII 100S.

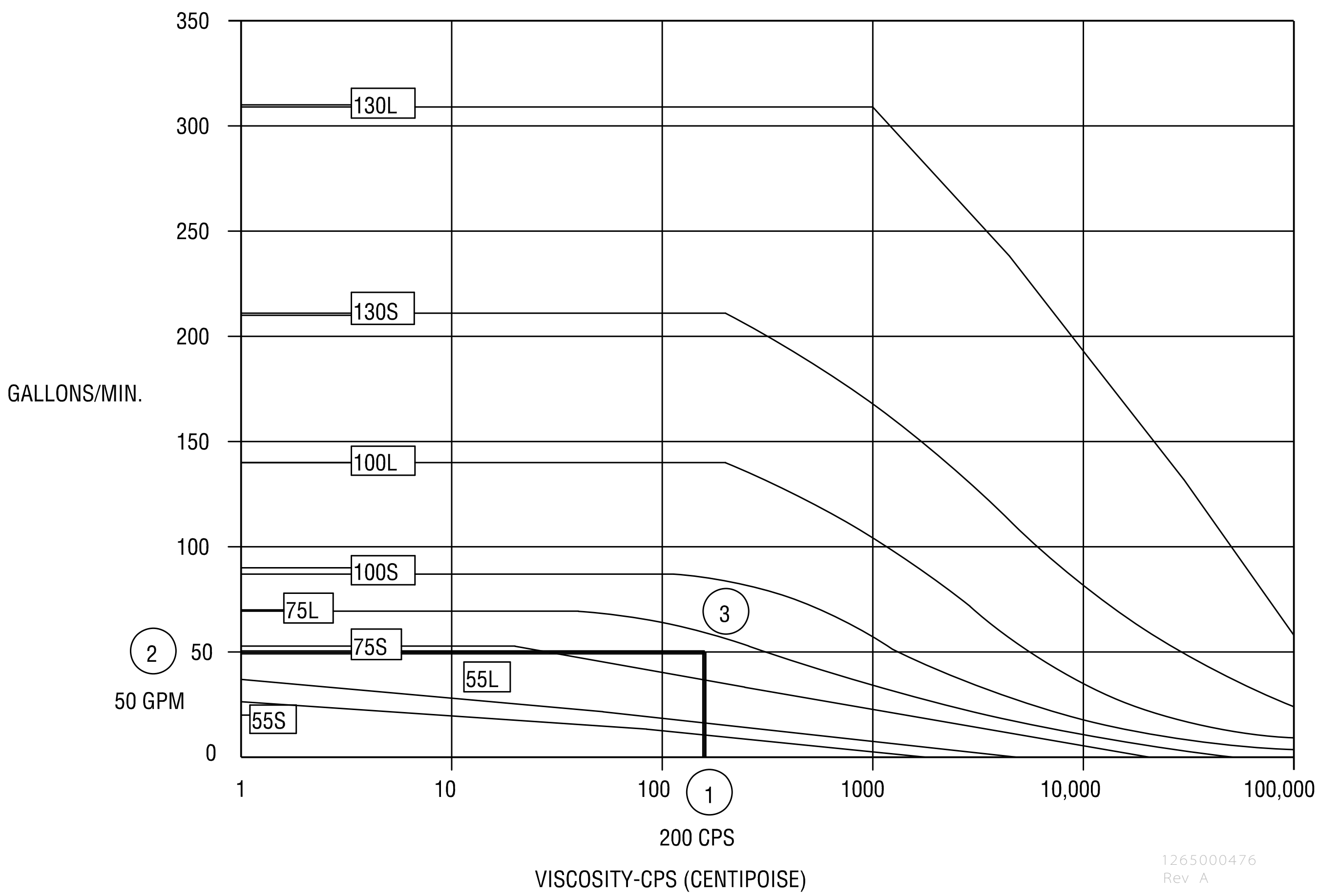


Figure 24

Determining Pump Speed

Viscosity Adjustment

Viscosity adjustment is not necessary for products with a viscosity above the pumps zero-slip point. Also viscosity adjustment is not necessary for products at 1 cps, since the curves are calculated at 1 cps. The zero slip point is 500 cps for the FLII and 200 cps for the FKL. Speed must be increased for products with a viscosity below the zero slip point in order to deliver the required flow rate. This is the most confusing part of PD selection. It is necessary because, as discussed on pages 58-61 (How a Positive Pump Operates), pump performance will vary for viscosities below the zero slip point. The adjustment converts the slip factor for different viscosity products into an equivalent based on water.

For the FLII, use the curve on page 31 and for the FKL use the curve on page 11.

1. Locate the calculated differential pressure on the vertical axis (1).
2. Follow the pressure line, down and to the right, until it intersects (3) the product viscosity (2).
3. Record the adjusted pressure value on the vertical axis (4). This value is the pressure that will be used on the slip curve.

FL II Viscosity Adjustment Curve

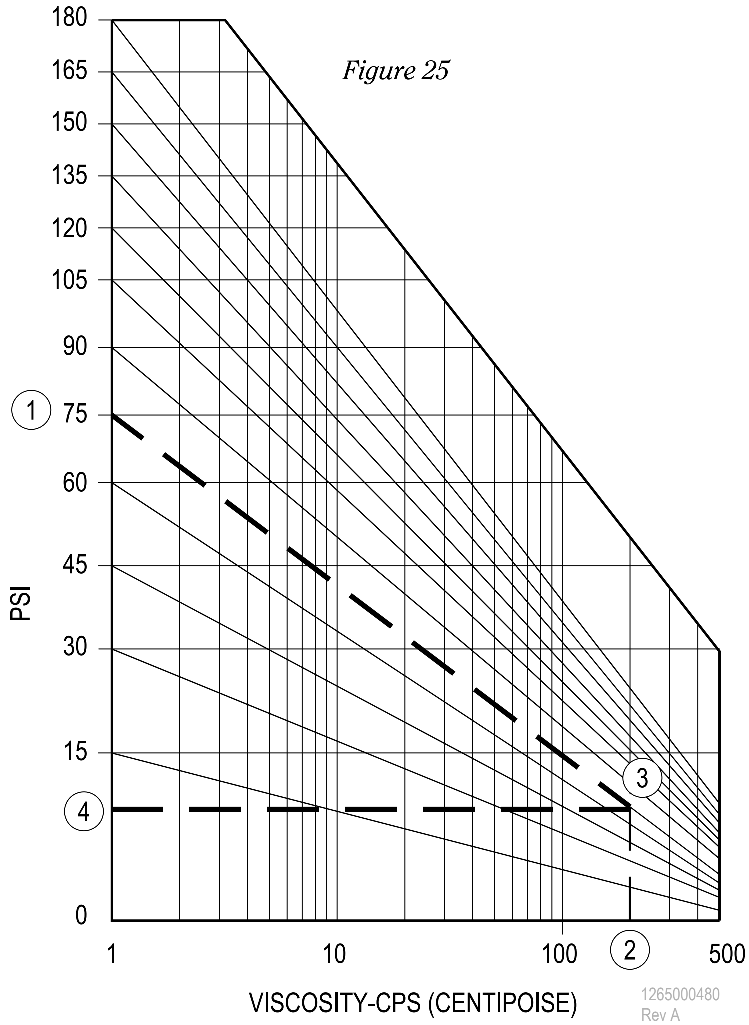


Figure 25

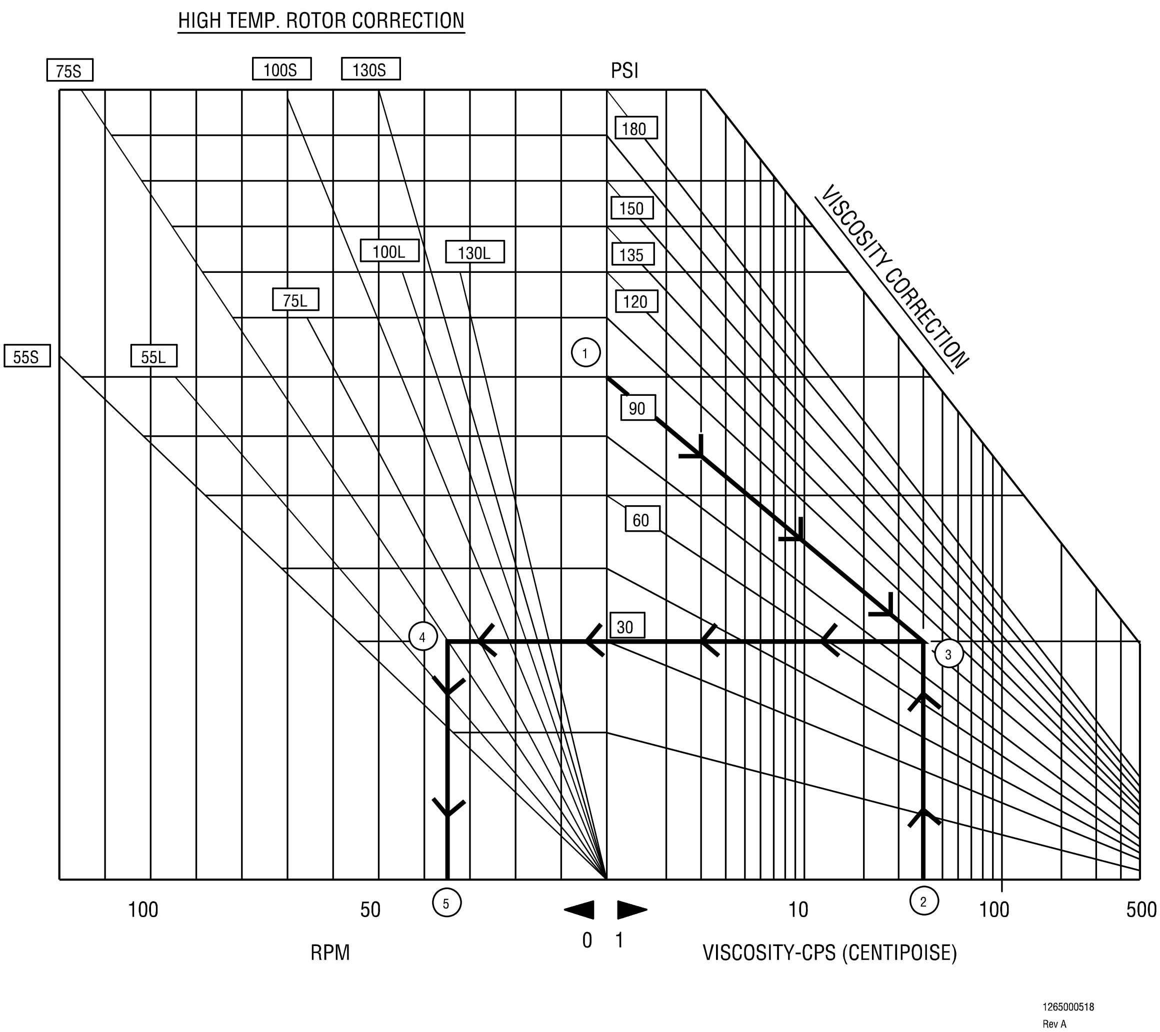
High Temperature Rotor Adjustment

For applications that fall below the zero slip point and require high temperature rotors, another speed adjustment is necessary. The increased clearances produced by these rotors require this adjustment, to compensate for the additional slip they produce.

For any of the FLII pumps, use the curve on page 32 and for the FKL pump use the curve on page 11.

1. Locate the calculated differential pressure on the vertical axis (1).
2. Follow the pressure line, down and to the right, until it intersects (3) the product viscosity (2).
3. Read all the way to the left until you find the line representing the model that was selected (4).
4. Record the additional speed at the horizontal axis (5). This number will be added to the speed calculated for the pump.

Figure 26 - FL II High Temperature Rotor Correction Curve



Determining Pump Speed

To determine the pump speed:

1. Locate the required flow rate on the pump curve (1).
2. Move horizontally until you intersect the correct pressure (2). This will depend on the viscosity of the product. For products with a viscosity of 1 cps, the correct pressure line will be the differential pressure. For viscosities between 1 and 500 cps for the FLII pump, the correct line will be the viscosity-adjusted pressure. For viscosities above 500 cps for the FLII, the correct line will be 0 psi.
3. Move straight down until you intersect the horizontal axis (3).

Determining Horsepower Requirements

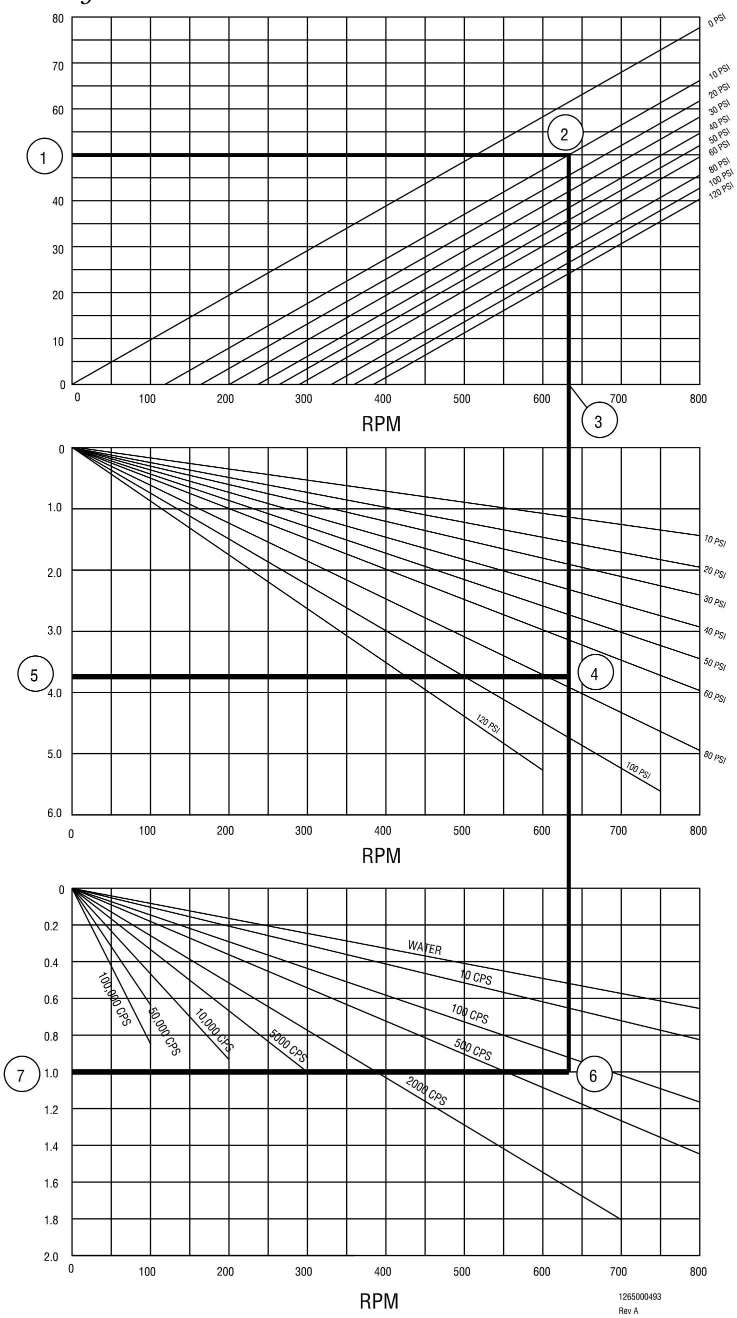
1. Determine the Work Horsepower (WHp). Continue to move down until you intersect the differential pressure (4), not the adjusted pressure. Read the power off the vertical axis directly to the left (5).

2. Determine the viscosity horsepower (VHp). Continue to move down (from the differential pressure point) until you intersect the product viscosity (6). Read the power off the vertical axis directly to the left (7).

3. Add these two numbers together to calculate the overall brake horsepower.

BHp = WHp + VHp

Figure 27



Net Inlet Pressure Required (NIPR)

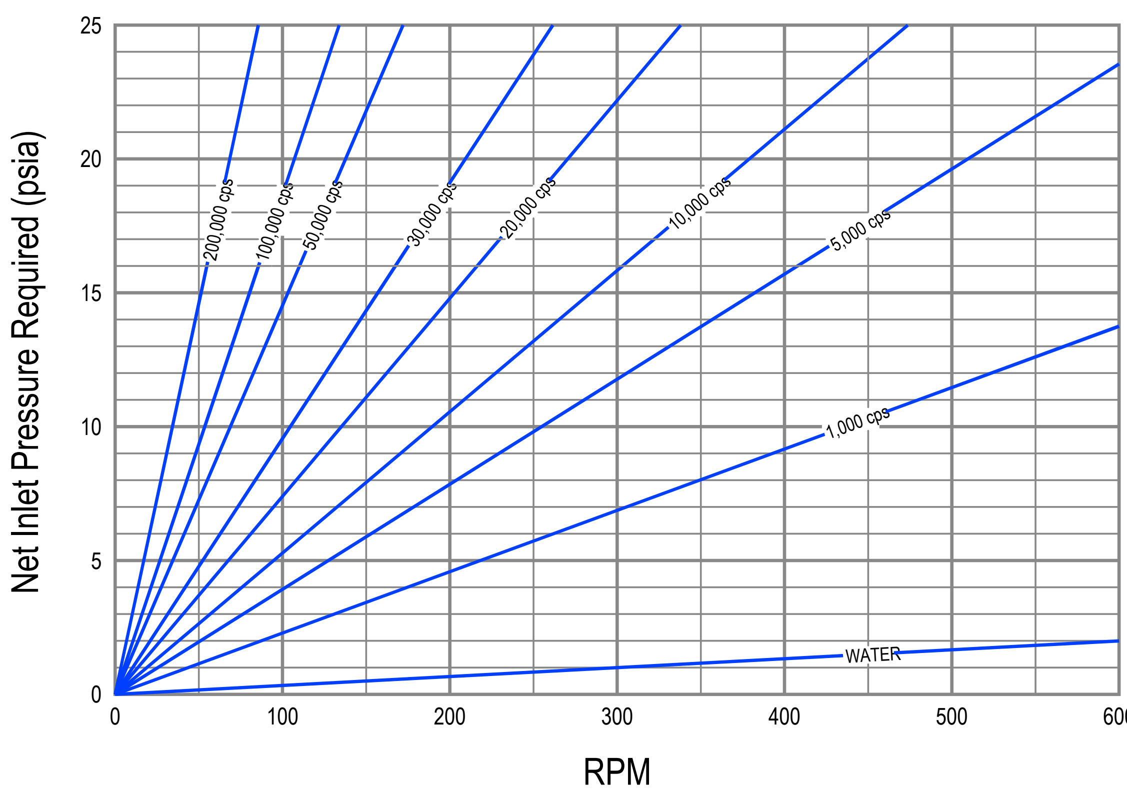
Check the Net Inlet Pressure Required (NIPR) for the selected pump. For the FLII pumps, be sure that the NIPR is at least 7 psia. For the FKL, each pump has its own curve.

Determining Drive Torque Requirements

Calculate the application torque. The application torque will be used to help size the pump drive and the coupling used to connect the drive to the pump. Each of these components will have a maximum allowable torque and the application torque cannot exceed this.

T = (63,025 x BHp) / speed

Figure 28: FKL 25 NIPR curve



1265000496
Rev A

Example 1

Water at 1 cps, 1.0 SG and 68°F

The duty will be 20 gpm @ 200 psi and the NIPA will be 4 psia

The pressure of this duty point exceeds the maximum of any of our FLII pumps and the NIPA is relatively low, therefore we will select a FKL pump for this application.

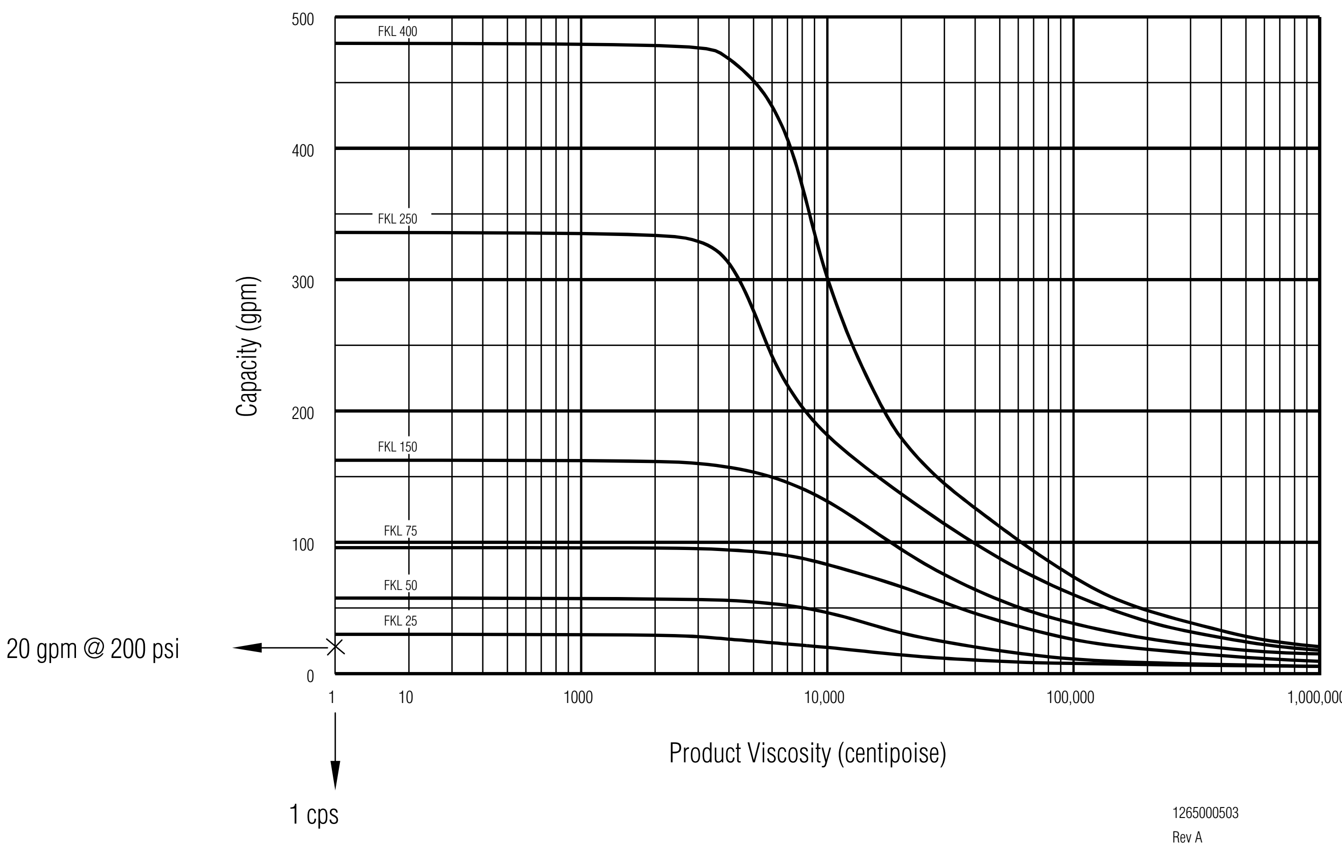
Look at the composite curve (page 11) and select a model. See page 72 for more explanation.

The model that will work best is the FKL 50.

This duty will not require a viscosity or temperature adjustment since the product is at 1 cps. The actual slip line can be read off the curve.

Calculate the pump speed, horsepower and application torque.

Figure 29



For example 1, the FKL 50 requires 494 rpm to deliver 1 cps product at 20 gpm against 200 psi.

BHp = WHp + VHp

BHp = 6.1 + 0.4

BHp = 6.5

T = Torque (in/lbs.)

T = (BHp x 63,025) / speed

T = (6.5 x 63,025) / 494

T = 829 in-lbs

Check the NIPR of the pump using Figure 30.

The NIPR is 2.7 psia, therefore the NIPA of 4 psia is more than enough. The final selection would be a FKL 50, running at 494 rpm with a 7.5 hp drive and having a torque of 829 in-lbs.

Figure 30

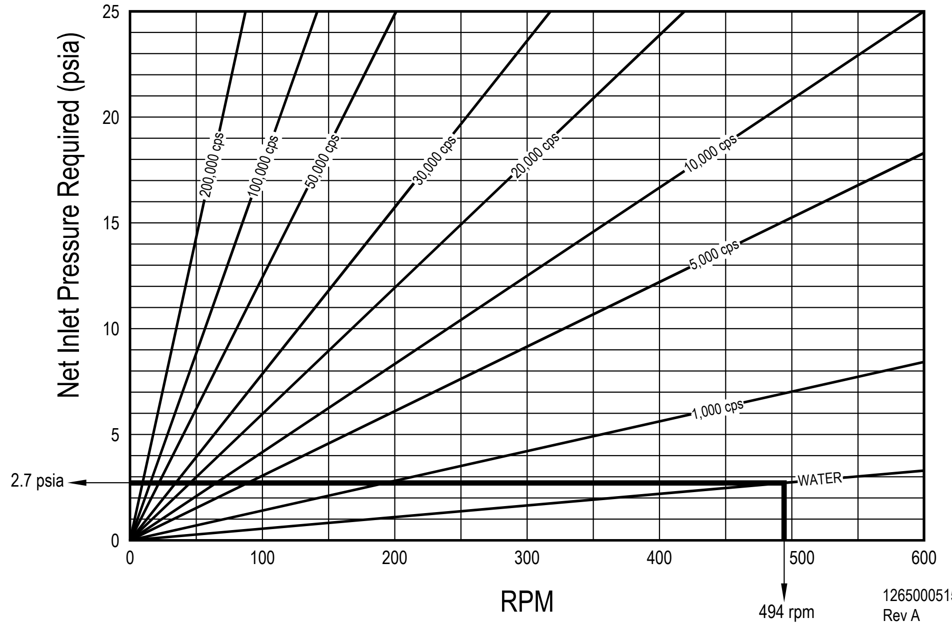
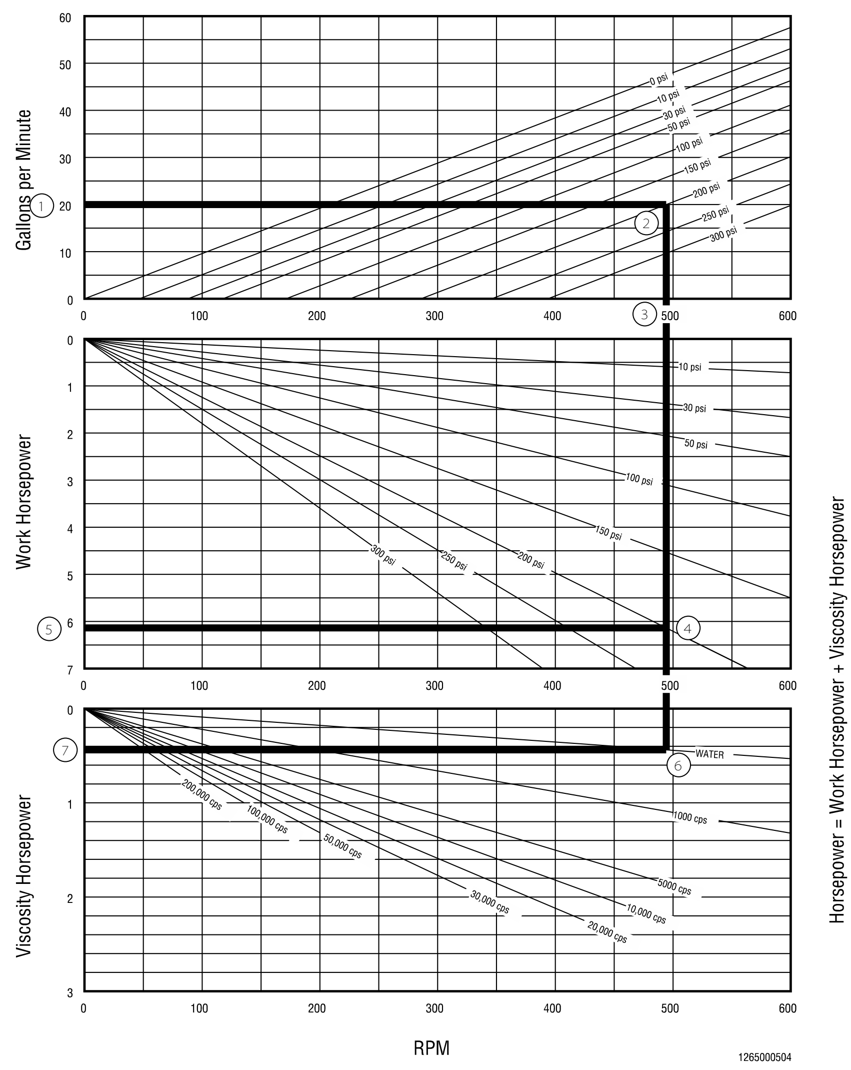


Figure 31



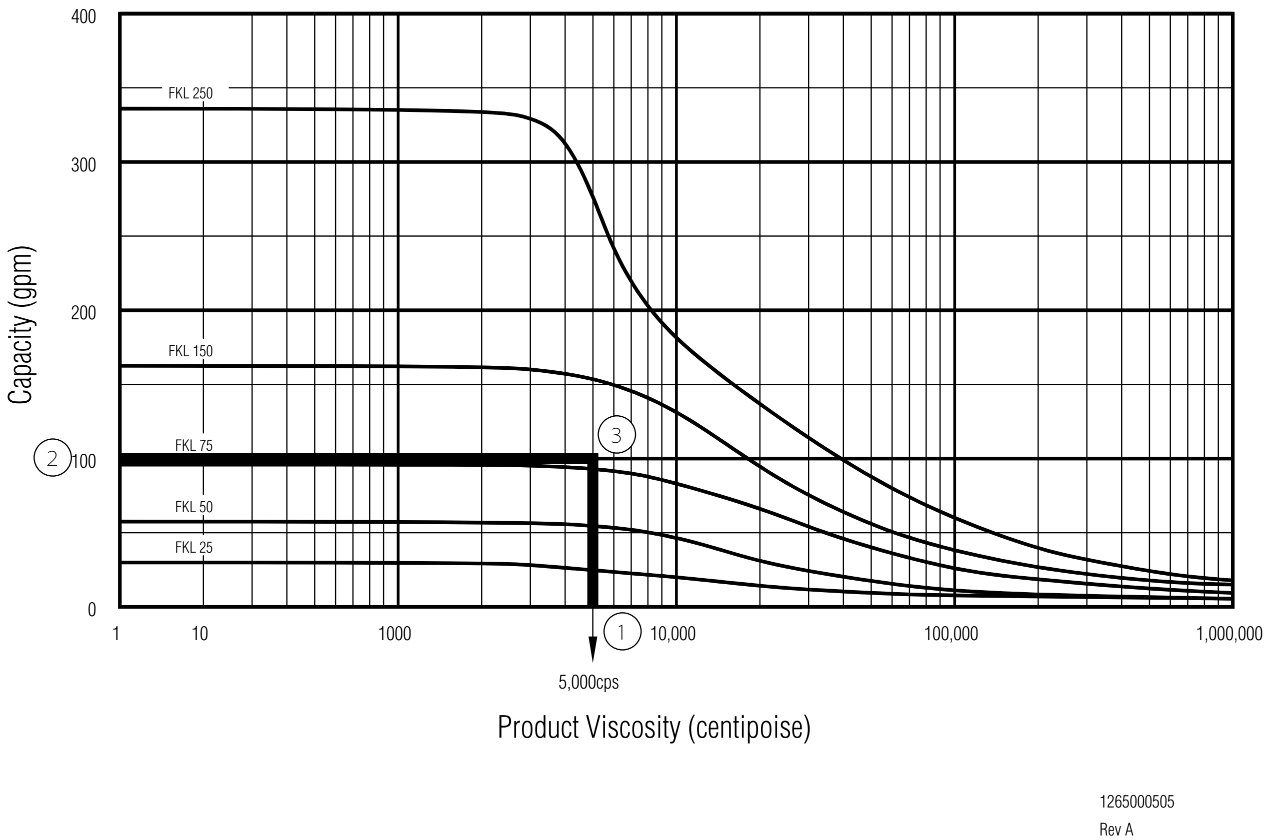
Example 2

High Fructose Corn Syrup at 5,000 cps, 1.32 SG and 38°F

The duty will be 100 gpm @ 250 psi and the NIPA will be 10 psia

The pressure of this duty point exceeds the maximum of any of our FLII pumps; therefore, we will select a FKL pump for this application. Look at the composite curve (Figure 32) and select a model. See page 72 for more explanation.

Figure 32

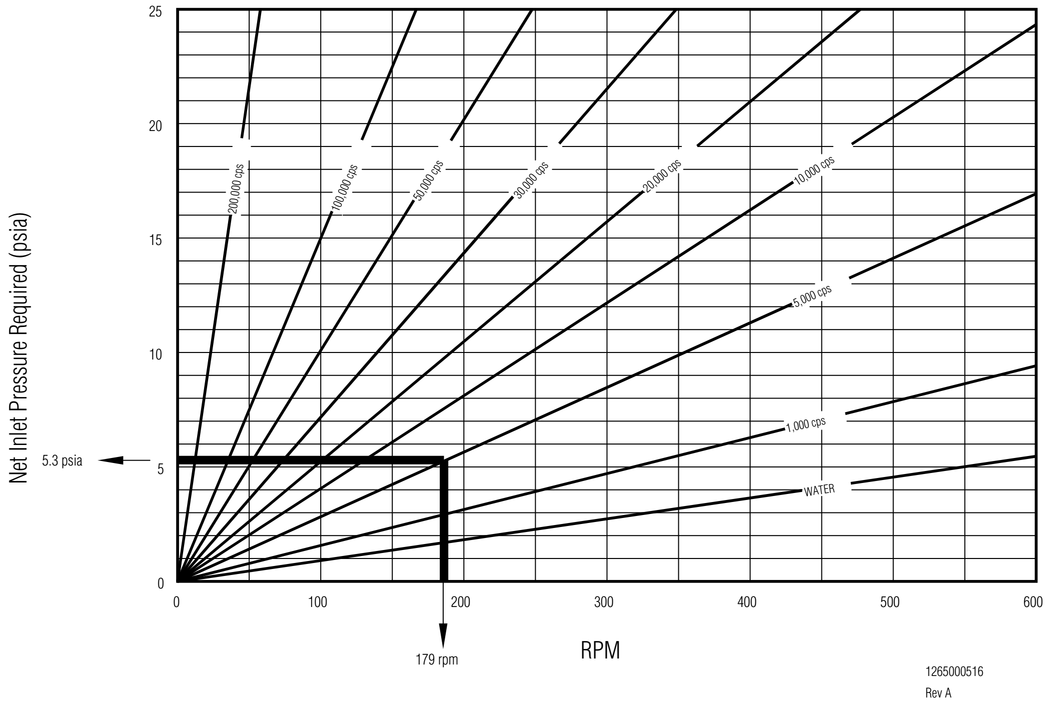


The model that will work best is the FKL 250. The FKL 150 is above the duty point, but the speed required is too high.

This duty will not require a viscosity or temperature adjustment.

Calculate the pump speed, horsepower and application torque. The speed can be calculated by dividing the flow rate by the displacement, or it can be found by reading the zero slip line on the slip chart.

Figure 33



For example 2, the FKL 250 requires 179 rpm to deliver 5,000 cps product at 100 gpm against 250 psi.

BHp = WHp + VHp

BHp = 17.5 + 5.0

BHp = 22.5

T = (BHp x 63,025) / speed

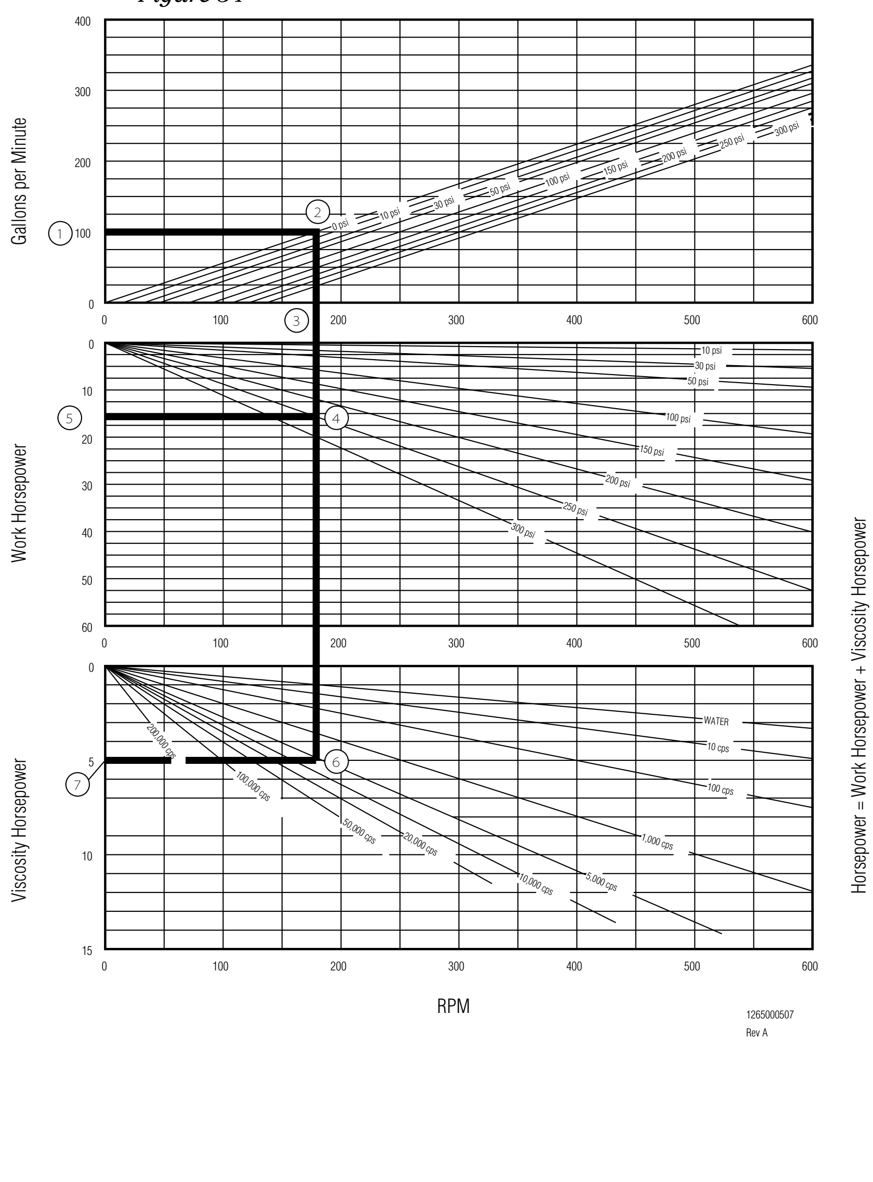
T = (22.5 x 63,025) / 179

T = 7,922 in-lbs

Check the NIPR of the pump using the NIPR curve Figure 33.

The NIPA of 10 psi will be more than the 5.3 psi required for the FKL 250. The final selection would be a FKL 250, running at 179 rpm with a 25 hp drive and having a torque of 7,922 in-lbs.

Figure 34

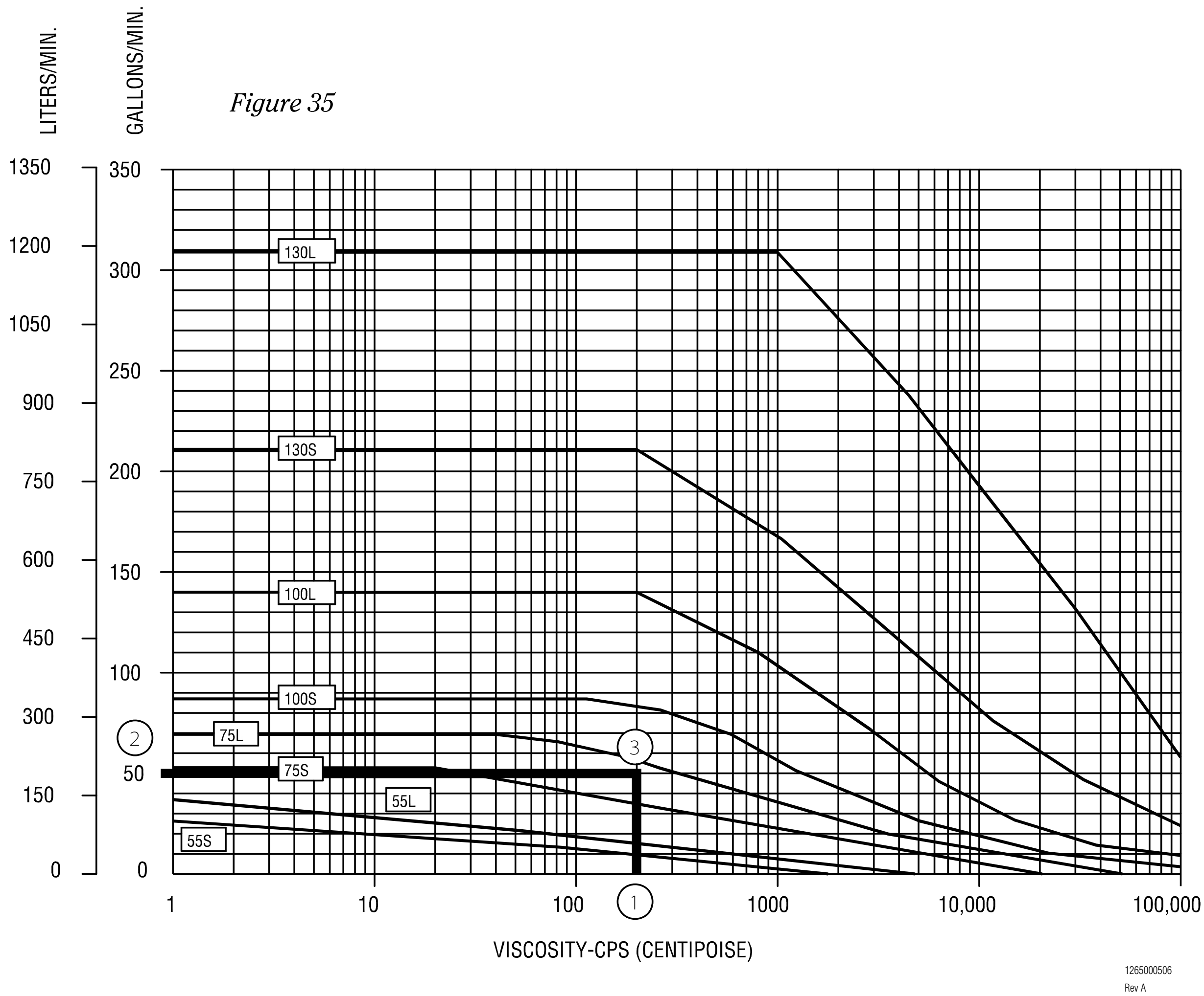


Example 3

Pie filling at 200 cps, 1.2 SG and 90°F

The duty will be 50 gpm @ 75 psi and the NIPA will be 10 psia

This is a simple application with a low duty point pressure and plenty of NIPA; therefore, we will select a FLII pump. Look at the composite curve (Figure 35) and select a model. See page 72 for more explanation.



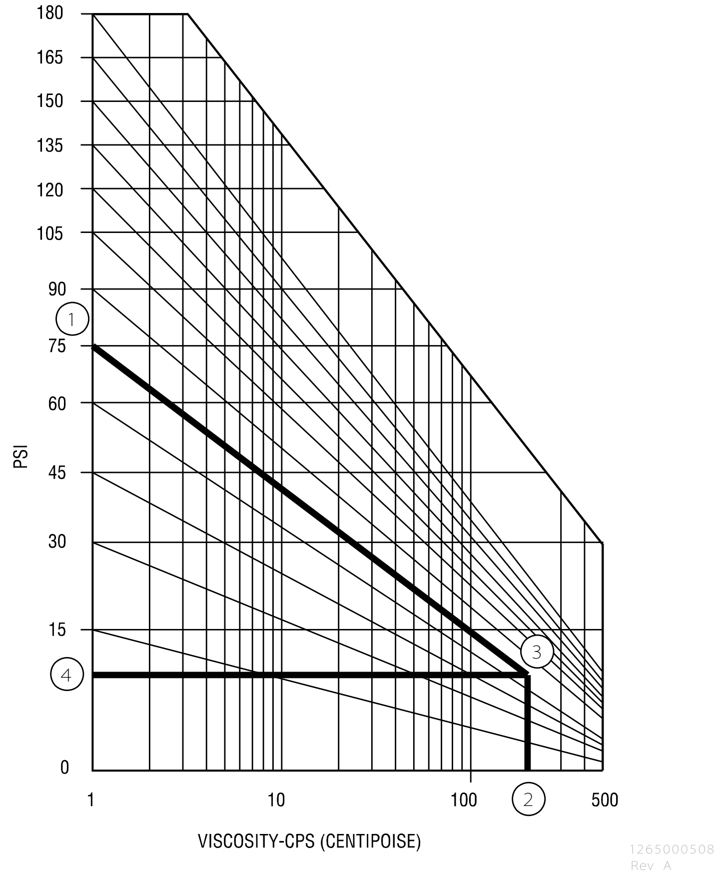
The FLII 100S is above the duty point. We will not select the FLII 75L for this application, because we are trying to keep the pump speed below the 400 – 500 rpm range.

This duty will require a viscosity adjustment, but will not require a high temperature adjustment.

Following the viscosity adjustment procedure for the FLII pump (pages 58-61), we determine the slip curve will be read on the 10 psi line.

The NIPA for the application is 10 psia, which is more than adequate for the FLII 100S.

Figure 36



Calculate the pump speed, horsepower and application torque.

For example 3, the FLII 100S requires 390 rpm to deliver 200 cps product at 50 gpm against 75 psi.

BHp = WHp = VHp

BHp = 4.2 + 1.2

BHp = 5.4

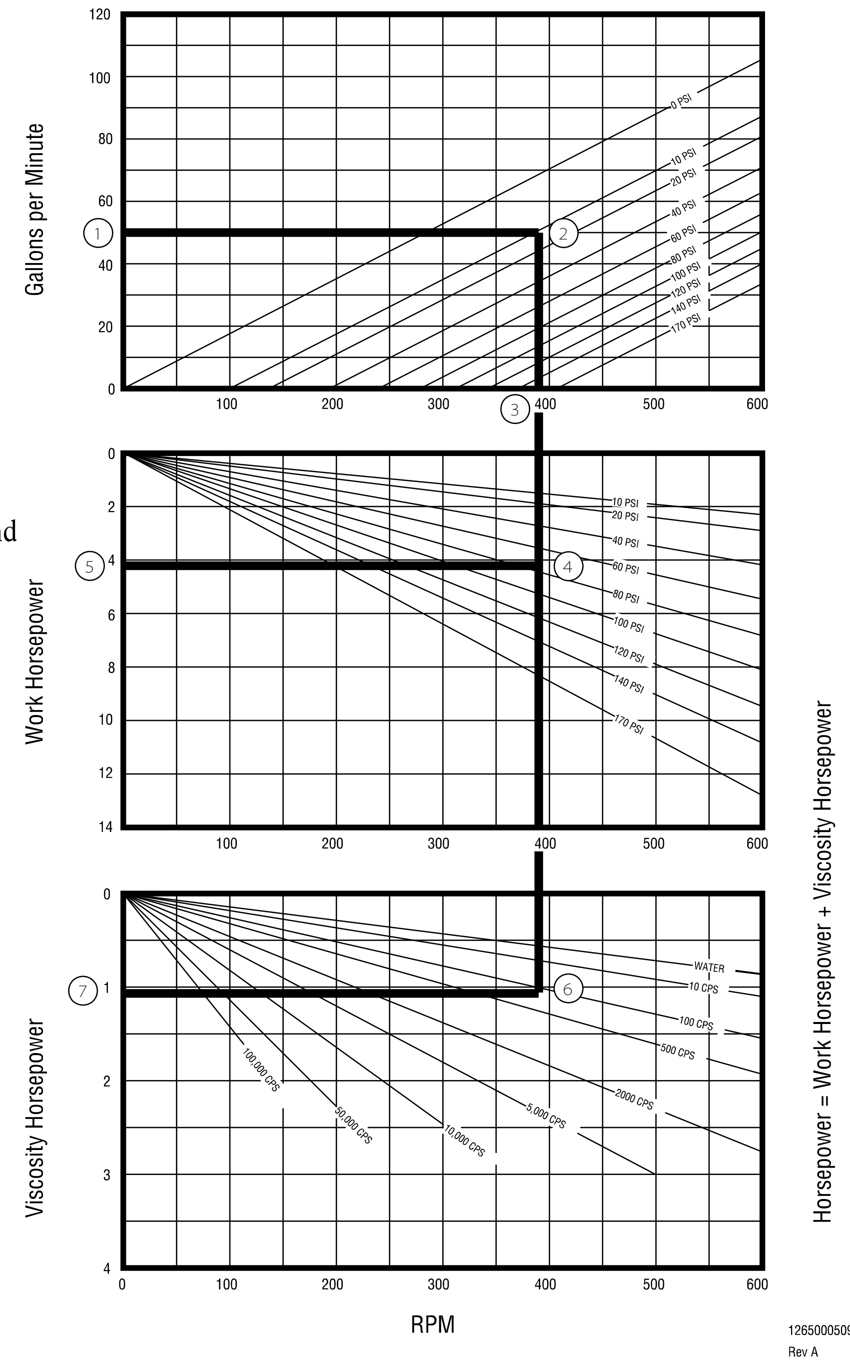
T = (BHp x 63,025) / speed

T = (5.4 x 63,025) / 390

T = 873 in-lbs

The final selection would be a FLII 100S, running at 390 rpm with a 7.5 Hp drive and having a torque of 873 in-lbs.

Figure 37



Example 4

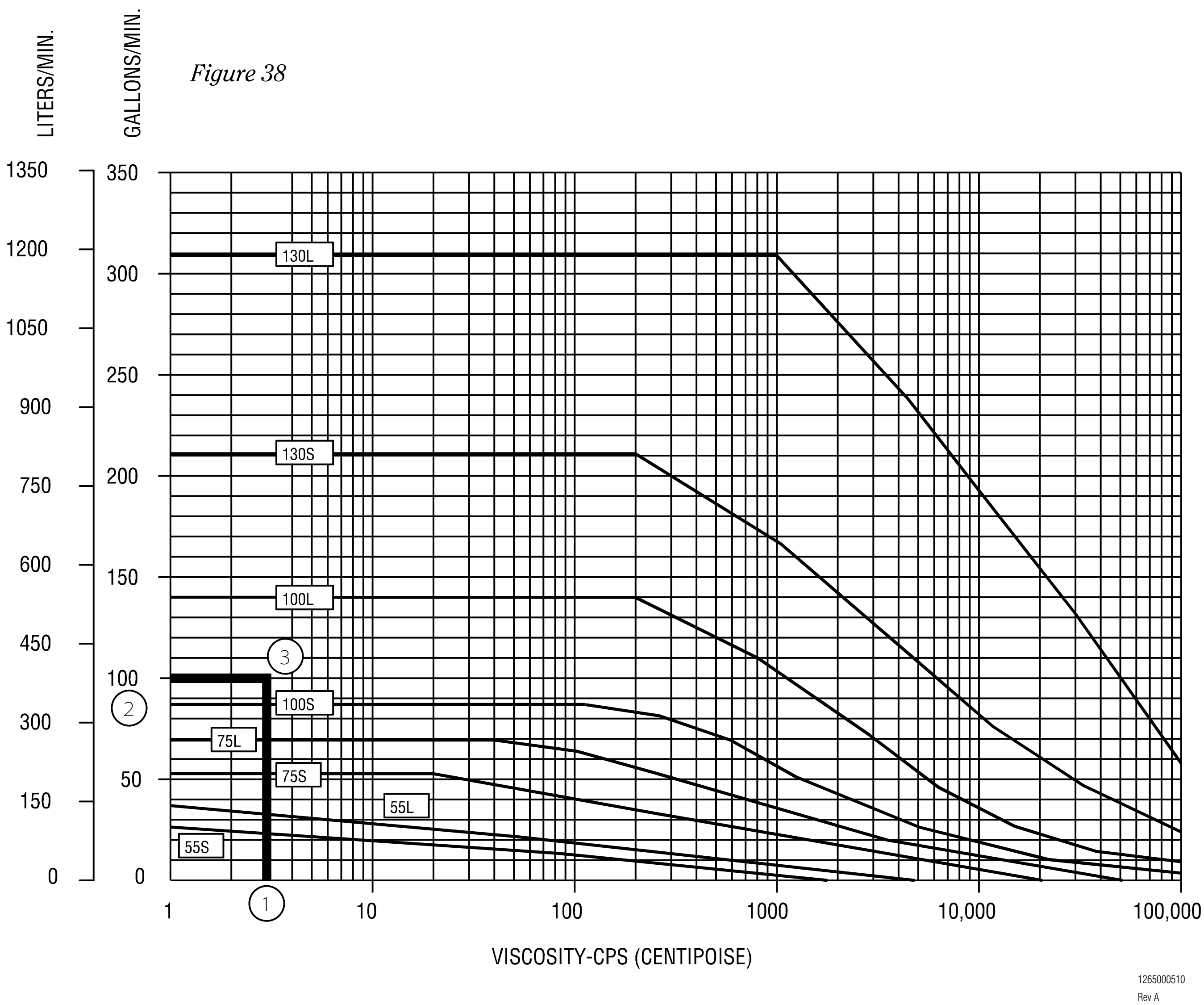
Vegetable Oil at 3 cps, 0.98 SG and 275°F

The duty will be 100 gpm @ 80 psi and the NIPA will be 10 psia

This is a simple application with a low duty point pressure and plenty of NIPA; therefore, we will select a FLII pump. Look at the composite curve (Figure 38) and select a model. See page 72 for more explanation.

The FLII 130S falls above the duty point and will fall within the preferred speed range.

Figure 38

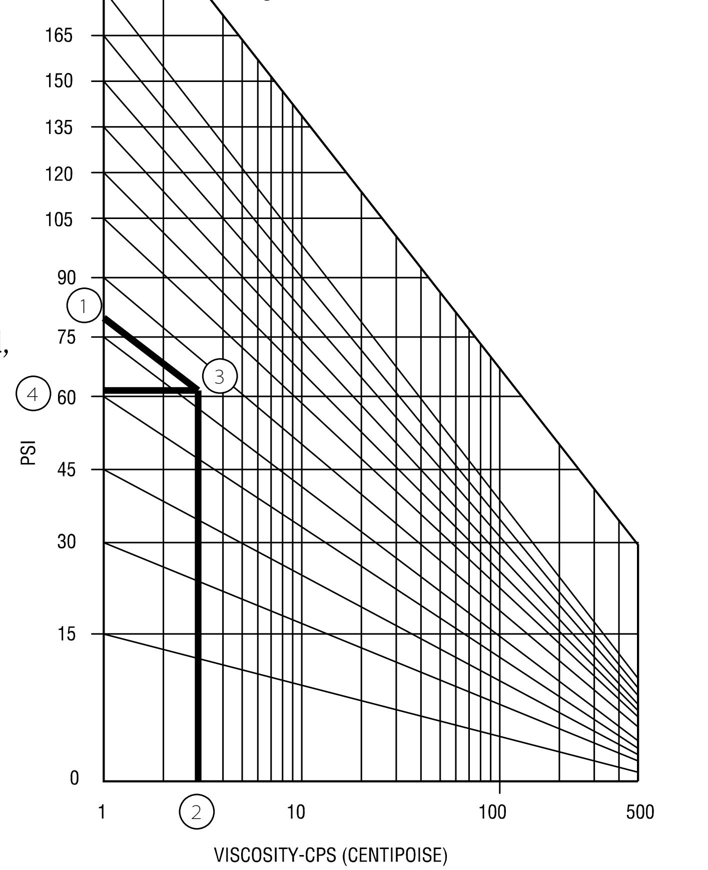


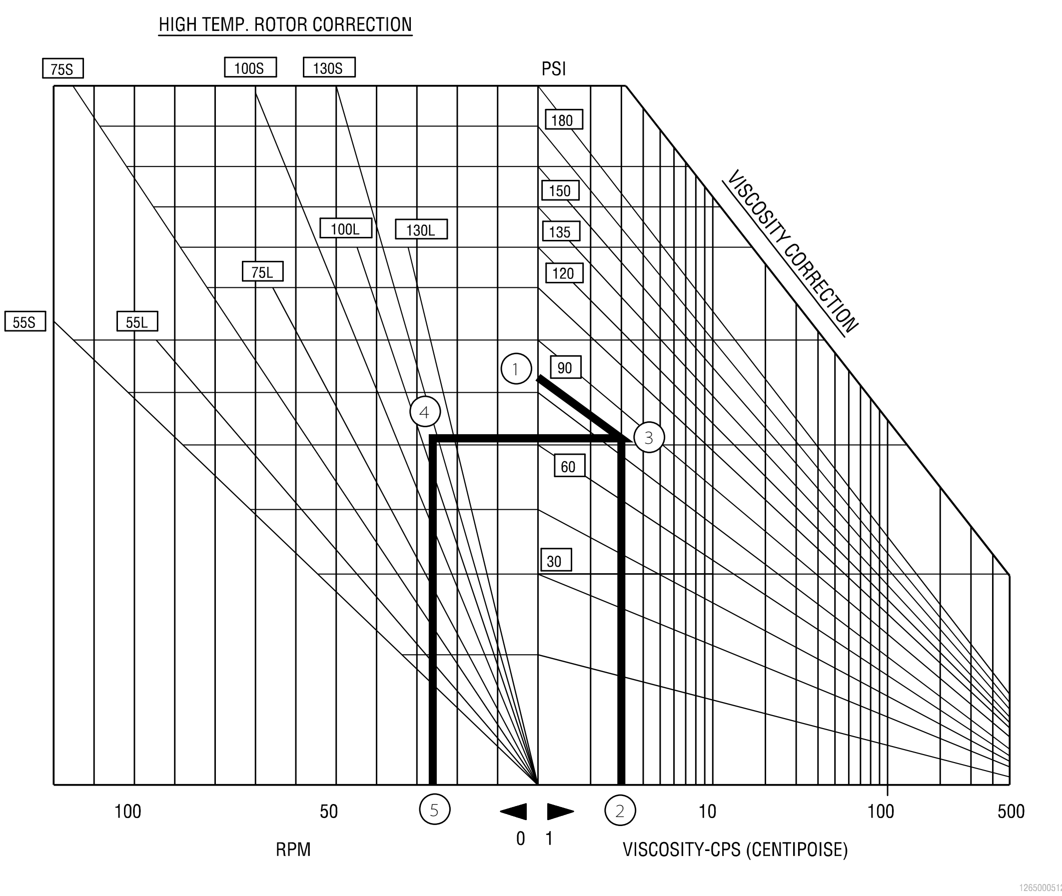
This duty will require a small viscosity adjustment and a high temperature adjustment.

Following the viscosity adjustment procedure for the FLII pump (pages 58-61), we determine the slip curve will be read on the 62 psi line.

Use the High Temperature Rotor Correction curve (Figure 40) to determine the speed adjustment. We will add 27 rpm to the speed, to compensate for the high temperature rotors.

Figure 39





The NIPA for the application is 10 psia, which is more than adequate for the FLII 130S.

Calculate the pump speed, horsepower and application torque.

For example 4, the FLII 130S requires 360 rpm to deliver 3 cps product at 100 gpm against 80 psi. We then need to add 27 rpm to the 360 rpm.

BHp = WHp + VHp

BHp = 10.0 + 1.5

BHp = 11.5

T = (BHp x 63,025) / speed

T = (11.5 x 63,025) / 387

T = 2,085 in-lbs

The final selection would be a FLII 130S, running at 387 rpm with a 15 Hp drive and having a torque of 2,085 in-lbs.

Figure 41