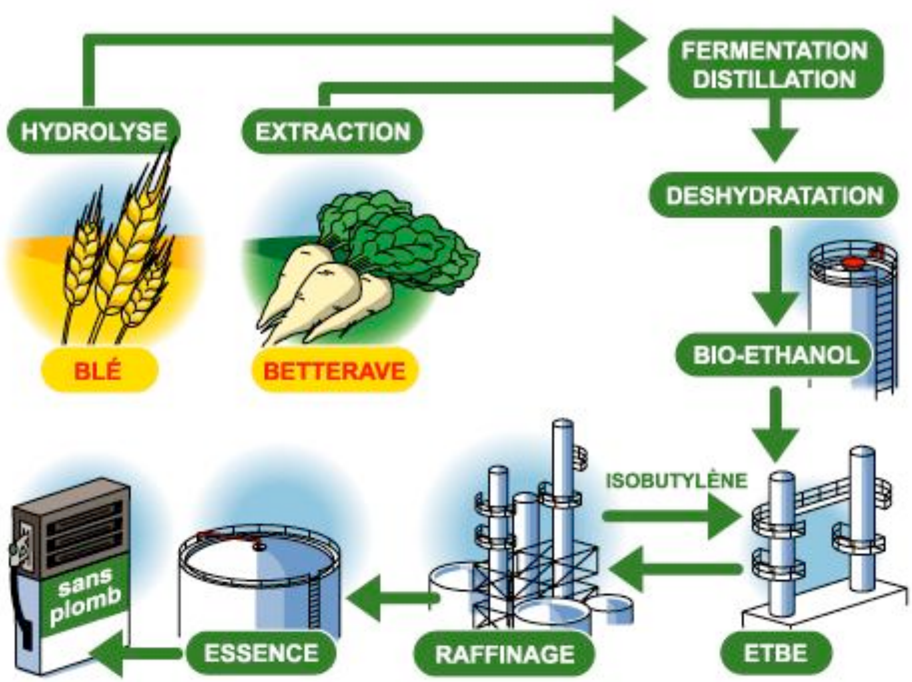
Lab

Pump Selection

Waukesha Displacement Pumps

Waukesha Positive Displacement Pump - Sanitary	Bio-ethanol
	

Bio-fuel flow chart


Summary

Summary

The selection of a displacement pump for an alcohol production (ethanol) plant will be discussed. The pump will be selected using the Waukesha manual. A procedure to solve the problem using spread sheet will be demonstrate during the lab.

4.1 Background

In designing a liquid transport system, the need for a pump is determined on the basis of flow and pressure requirements. In selecting a pump for a given system, it is imperative that the characteristics of the system are closely defined. The pump requirements are based on the system characteristics. The following information about the system must be known:

flow rate of liquid, the required differential pressure, the available net positive suction head, the pump capacity, pump speed, characteristics of the fluid.

4.2 Objectives

1.) To present the Waukesha manual

2.) To use the manual to select a pump for an alcohol production plant

3.) To solve the problem using spread sheet

4.) To use the spread sheet to change the system for appricot puree

4.4 Procedure

a.) Using the spread sheet presented in class, modify your system to transport mayonnaise, considering the following:

- mayonnaise is a thixotropic material and can be described by:

$$\sigma = \lambda[7 + 28.5\dot{\gamma}^{0.32}]$$
$$\lambda = (0.012\dot{\gamma}^{0.13}t + 2.70)^{-1} + 0.063$$

- the material will be transported from tank1 (processing) to the filling nozzles located a distance no less than 5 m from the pump.

- the pump will be located at 2 m from tank1 exit

- Calculate the viscosity at $t = 0$ for given shear rate - after being transported to the filling nozzles calculate the viscosity at the shear rate you selected to transport - the final viscosity must be large or equal 30% of initial viscosity
- density is 1200 kg/m3
- selected the pipe diameter, the flow rate, and system layout

b.) determine the maximum velocity in the pipe

c.) determine the maximum safe distance L that the pump can be located

d.) discuss the significance of fluid rheological characteristics in pump selection

Pump selections - to transport sugar cane must

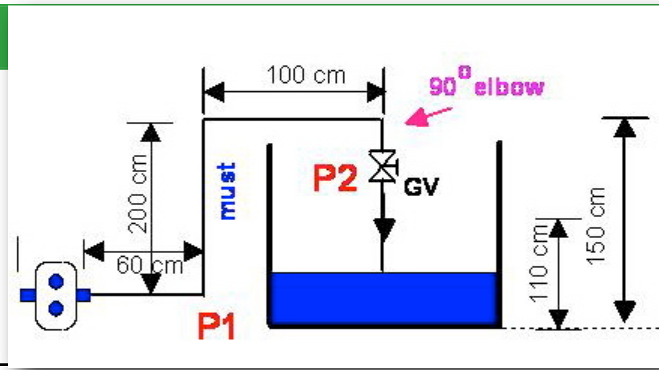
From must tanks to fermentation vats

(1) GPM and viscosity

Using the VB program

Using the worksheet - INPUT

Note: do not write in the cells that are in white



Preliminary choice - based on GPM x viscosity

n = 1, k = 0.0015 Pa.s; density = 1176 kg/m^3; P_v = 7.11 psia

2000 L/h = ____________________ L/min =_____________GPM

Pipe size = 1.5 in = ____________ m

Velocity of must = *u* = *Q/A* = ___________m/s

Determine Reynold's number for the Newtonian Fluid

$$N_{Re,N} = \left(\frac{D(\bar{u})\rho}{\mu}\right)$$

Re = _________ Recrit = _________ Flow regime = ______________.

Determine the friction factor - *f* - also called fanning factor

f = _______________.

Determine the effective viscosity

$$\mu_e = \frac{f\dot{m}}{4\pi D}$$

μ_e = ____________cPs

PReliminary PUMP choice - based on GPM x viscosity: _________.

Pump selections - to transport sugar cane must

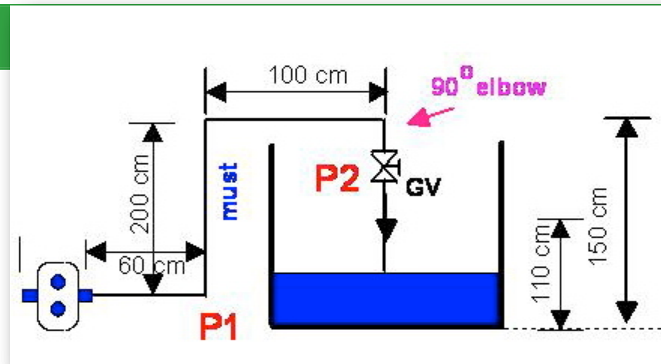
From must tanks to fermentation vats

(2) Discharge Limitations

waukesha pump can withstand a pressure difference of 200 psi (1370 kPa)

using the tab - DischargePre

using the tab - NIPR



Calculate the Pressure needed to pump the fluid to the fermentation vat

The energy balance from the pump to the fermentation tank

$$\frac{u_2^2 - u_1^2}{a} + \frac{P_2 - P_1}{\rho} + (z_2 - z_1)g + \Sigma F = -W$$

$$u_2 = u_1; P_2 = 0; W = 0; \ (z_2 - z_1) = 0.9$$

$$P_1 = [(z_2 - z_1)g + \Sigma F]\rho$$

$$\Sigma F = \frac{2fu^2 L}{D} + \Sigma \frac{k_f u^2}{2}$$

L = ________ m;

elbows =_________kf EL=_________.

#gate valve= ___________ kfGV= _________.

∑F = __________J/kg

P1 = ____________ Pa = ___________psig

P1 + Patm = _________+ 14.69 psia = ____________.

Will the pump withstand a 200 psi pressure drop? ____________.

Pump speed

From manual GPR = ______,

speed = GPM/GPR = ______________ rev/min

Pump selections - to transport sugar cane must

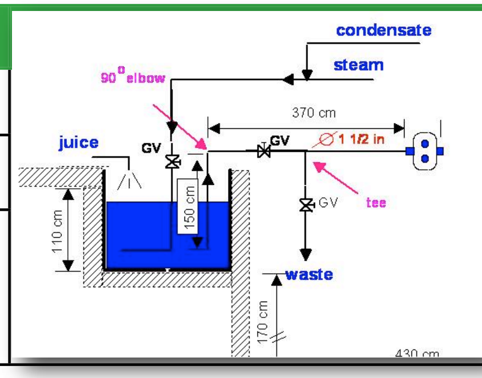
From must tanks to fermentation vats

(3) NIPA vs NIPR

NIPA > NIPR otherwise the pump will cavitate

Using the worksheet - NIPR

using the worksheet - NIPA



Calculate the Pressure needed to pump the fluid to the fermentation vat

The energy balance from

the must tank to the pump

$$\frac{u_2^2-u_1^2}{a}+\frac{P_2-P_1}{\rho}+(z_2-z_1)g+\Sigma F=-W$$

$$z_2-z_1=1.5; u_1=0; P_1=0; W=0$$

$$P_2=\rho\left[-z_2 g-\frac{u_2^2}{a}-\Sigma F\right]$$

From manual

________ pump; NIPR =________psia

L =___________m

elbows =_________kf EL=_________.

#gate valve= ___________ kfGV= _________.

#tee = ___________ kf T= _________.

∑F = __________J/kg

P2 = ____________ Pa = ___________psig

P2 + Patm = _________+ 14.69 psia = __________.

NIPA = P2 - Pvapor = P2 - 7.11 = ____________. psia

NIPA _____NIPR

Power requirement

W = (P1-P2)/ρ = _______J/kg; HP = ______; T = HP 5250/spd =_______ft-lb < _____OK?

CHANGE THE FLUID RHEOLOGICAL PROPERTIES

n = 0.35

K = 8.9 Pa s^n

Re =__________Recrit =______________Flow regime = _____________.

f = __________.

Pump size = ________________.

Maximum length = _______________.

BACK TO NEWTONIAN FLUID - Change Q to 5000 L/h

n = 1

K = 0.0015 Pa.s

Re =__________Recrit =______________Flow regime = _____________.

f = __________.

Pump size = ________________.

Maximum length = _______________.

BACK TO Q to 2000 L/h - Change the pipe diameter to 3 in

n = 1

K = 0.0015 Pa.s

Re =__________Recrit =______________Flow regime = _____________.

f = __________.

Pump size = ________________.

Maximum length = _______________.