Beverage Fermentation Class Case Study Workshop

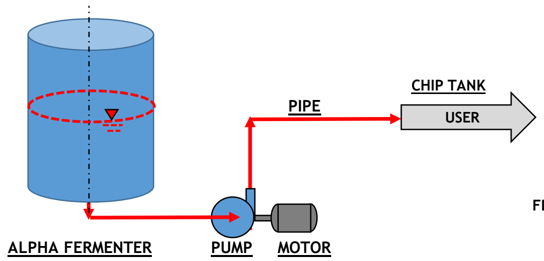
ESG Processes at Anheuser Busch, Inc.

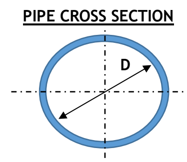
Brewery Fermentation Transfer of Beer

Energy Calculations with Fluid Hydraulic Pump Head

LEGEND:

GIVEN DATA:	(green)
FIND CALC:	(blue)
SOLUTION:	(yellow)

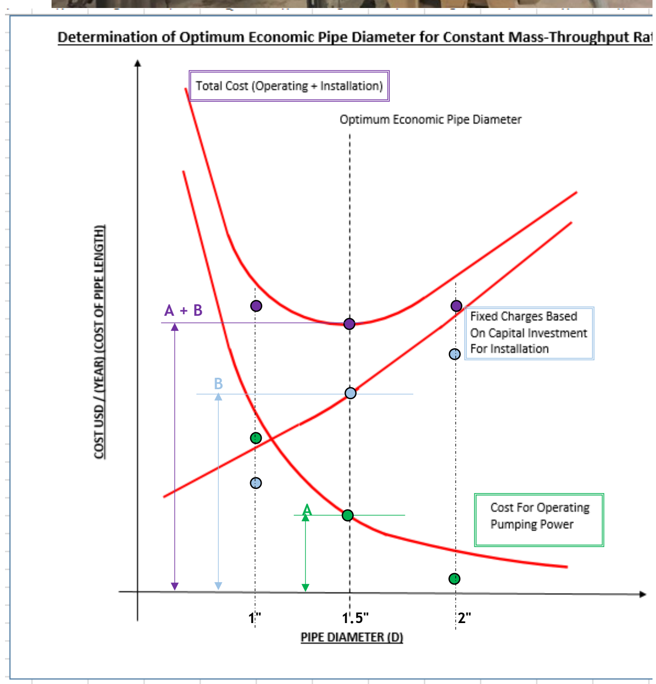




FLUID: Krausen Beer, BKR

BISECTION METHOD SOLUTION

				SMALL	LARGE	MIDPOINT	
			Nominal Size	1"	2"	1.5"	Inch
Pipe Fluid Flow Velocity	Run # 1	Run # 2	Run # 3	Run # 1	Run # 2	Run # 3	Units
Constant Flow Rate (Q)	(GIVEN)		Q	30	30	30	GPM
Schedule 5 S Inside Pipe Diameter (d) =	(GIVEN)		d	Actual Inside Dimension 1.1850	2.2450	1.7700	Inch
Pipe Installed Cost/Foot =	(GIVEN)			$10.00	$20.00	$12.50	$ / Ft
Pipe Equivalent Length =	(GIVEN)			1,000	1,000	1,000	Ft
Pipe Installed Cost (est.)	(GIVEN)	(Material & Labor Costs)		$10,000	$20,000	$12,500	$
Fluid Velocity (v) =	0.408 * Q / d^2 = v		(FIND) V				Ft / Sec
Fluid Density (ro) =	(GIVEN)	(Krausen Beer)	ro	62.6	62.6	62.6	Lbs / Cu Ft
Fluid Viscosity (cP) =	(GIVEN)	(Krausen Beer)	cP	1.1	1.1	1.1	cP
Reynolds Number (Nre) =	123.9 * ro * v * d / cP = Nre		(FIND) Nre				N/A
Fluid Specific Gravity (SG) =	(GIVEN)	(Krausen Beer)		1.10	1.10	1.10	N/A
Friction Factor (f) =	| 1.8 LOG Nre / 7 |^(-2) =		(FIND) f				N/A
Head Loss (Ft/1,000') =	0.0311 * f * 1,000' *Q^2 /d^5		(FIND) hL				Ft / 1,000'
Pump Efficiency (ep) =	(GIVEN)		ep	0.70	0.70	0.70	N/A
Pump Brake Hp (BHp) =	Q * Ft * SG / 3,960 / ep =		(FIND) BHp				BHp
Motor Efficiency (em) =	(GIVEN)		em	0.65	0.65	0.65	N/A
Pump Motor Horsepower (MHp) =	BHp / em =		(FIND) MHp				MHp
Pump Horsepower (Hp) =	(PUMP MOTOR HP TABLE)		(FIND) Hp				Hp
Pump Motor Energy (W) =	MHp * 745.7 Watts / Hp =		(FIND) W				Watts
Pump Motor Installed Cost =	(PUMP MOTOR HP TABLE)		(FIND) $Pins				$ Pins
Pump Motor Operating Cost =	Watts * $0.07 / W =		(FIND) $POpCs				$POpCs
				1" Dia.Min.	2" Dia.Max.	1.5" Dia.	
System Instal & Oper. Cost =	Pipe Cost + Motor Cost + Op Cost =		(SOLUTION) $SC				$SC
* Operating Carbon Footprint (CFP) (Not a Pump CFP Life Cycle Analysis)	Lbs CO2 / 1,000 Hr =		(SOLUTION) CFP				CFP
Most Sustainable (OPTIMUM) =			(RECOMMENDATION)				



Comment: Based on the Optimum Economic Pipe Diameter Graph the economic choice would be a

Comment: 1.5" pipe cost is low, but with a future motor replacement cost is the same as a 2" pipe

Comment: 2" pipe has the lowest Carbon Footprint compared to the 1" and the 1.5" Pipes

Comment: Select the 2" pipe with the lowest Carbon Footprint and the lowest maintenance costs

Comment: For CIP of the 2" pipe selection a VFD CIP pump will be used to get velocities between 5

STANDARD PUMP MOTOR HORSEPOWER & COST (estimated) TABLE

0.25	Hp	$100	3	Hp	$1,200	25	Hp	$10,000	100	Hp	$40,000
0.5	Hp	$200	5	Hp	$2,000	30	Hp	$12,000	125	Hp	$50,000
0.75	Hp	$300	7.5	Hp	$3,000	40	Hp	$16,000	150	Hp	$60,000
1	Hp	$400	10	Hp	$4,000	50	Hp	$20,000	200	Hp	$80,000
1.5	Hp	$600	15	Hp	$6,000	60	Hp	$24,000	250	Hp	$100,000
2	Hp	$800	20	Hp	$8,000	75	Hp	$30,000	300	Hp	$120,000

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