HEAT LOAD CALCULATION.

EQUIPMENT :   DEGREENED LENTEIN DRYING SYSTEM.

CLIENT :   M/S PARABEL USA Inc

CONSULTANT: M/S KERONE. MUMBAI.

DESIGN DATA :

PROCESS DESIGN BASIS.

INPUT FEED :   WET DEGREENED LENTEIN.

DRYING RATE REQUIRED :   450   Kgs / Hr

FEED SPECIFICATION :

TOTAL MASS FLOW	450	Kgs / Hr
INLET TEMPARATURE :	25	^{0}C
INLET PRESSURE :	ATM	

FEED COMPOSITION.   (BY WEIGHT PER HOUR)

CARBOHYDRATES.	78.08	Kgs / Hr
PROTEINS.	71.54	Kgs / Hr
ASH	8.29	Kgs / Hr
WATER	20.89	Kgs / Hr
ETHYL ALCOHOL.	271.20	Kgs / Hr
TOTAL	450.00	Kgs / Hr

IT IS SUGGESTED THAT TWO DRYERS WOULD BE USED SO THAT

DRYER # 1 :   TO EXTRACT ALCOHOL FROM THE FEED , SO THAT DESIRED FDA ALCOHOL LEVEL IS ACCOMPLISHED.
ALONG WITH PART OF WATER VAPOR.

DRYER # 2 :   MAINLY TO REDUCE THE MOISTURE IN THE FEED AND GET THE DESIRED FINAL PRODUCT.

DRYER # 1

AS THE PRODUCT TO BE DRIED IS HEAT SENSITIVE THE TEMPARATURE IN THE DRYES SHOULD NOT BE MORE THAN 75 ^{0}C AT ANY TIME.

HEAT LOAD CALCULATION.

FEED COMPOSITION.　　(BY WEIGHT PER HOUR)

CARBOHYDRATES.	78.08	Kgs / Hr
PROTEINS.	71.54	Kgs / Hr
ASH	8.29	Kgs / Hr
WATER	20.89	Kgs / Hr
LATENT HEAT OF VAPORISATION OF WATER	550	K Cal / Kg.
ETHYL ALCOHOL.	271.20	Kgs / Hr
LATENT HEAT OF VAPORISATION OF ETHYL ALCOHOL	195	K Cal / Kg.

AS THE MAXIMUM OPERATING TEMPARATURE TO BE 75 ^{0}C ONLY

IN OUR CALCULATION WE ARE CONSIDERING MAX OF 72 ^{0}C ONLY

A.　　SENSIBLE HEAT LOAD

1　CARBOHYDRATES.

SPECIFIC HEAT OF CARBOHYDRATES		0.45	K Cal / Kg.^{0}C
MASS LOAD		78.08	Kgs / Hr
TEMPARATURE	INITIAL	25	^{0}C
	FINAL	72	^{0}C
	Δt	47	^{0}C
HEAT LOAD	m*Cp*Δt	1651.39	K Cal / Hr

2　PROTEINS

SPECIFIC HEAT OF PROTEINS		0.45	K Cal / Kg.^{0}C
MASS LOAD		71.54	Kgs / Hr
TEMPARATURE	INITIAL	25	^{0}C
	FINAL	72	^{0}C
	Δt	47	^{0}C
HEAT LOAD	m*Cp*Δt	1513.07	K Cal / Hr

3　ASH

SPECIFIC HEAT OF ASH		0.45	K Cal / Kg.^{0}C
MASS LOAD		8.29	Kgs / Hr
TEMPARATURE	INITIAL	25	^{0}C
	FINAL	72	^{0}C
	Δt	47	^{0}C
HEAT LOAD	m*Cp*Δt	175.33	K Cal / Hr

4　WATER

SPECIFIC HEAT OF WATER		1	K Cal / Kg.^{0}C
MASS LOAD		20.89	Kgs / Hr
TEMPARATURE	INITIAL	25	^{0}C
	FINAL	72	^{0}C
	Δt	47	^{0}C
HEAT LOAD	m*Cp*Δt	981.83	K Cal / Hr

5   ETHYL ALCOHOL

SPECIFIC HEAT OF ETHYL ALCOHOL		0.59	K Cal / Kg.^{0}C
MASS LOAD		271.20	Kgs / Hr
TEMPARATURE	INITIAL	25	^{0}C
	FINAL	72	^{0}C
	Δt	47	^{0}C

HEAT LOAD	m*Cp*Δt		7520.38	K Cal / Hr
	TOTAL SENSIBLE HEAT REQUIRED WILL BE		11842.00	K Cal / Hr
		SAY	**12000**	**K Cal / Hr**

B.   LATENT HEAT LOAD :

THE DRYER WILL BE WORKING UNDER VACUUM. CONSIDER A VACUUM OF 210 mm Hg.

AT THIS PRESSURE THE BOILING POINT OF ETHYL ALCOHOL WILL BE 70 ^{0}C

HENCE AT 72 ^{0}C ALLMOST ALL THE ALCOHOL PRESENT IN THE FEED WILL BE VAPORISED.

THE HEAT LOAD REQUIRED TO VAPORISE AT THIS TEMPARATURE WILL BE ;

1 ETHYL ALCOHOL.

MASS LOAD			271.20	Kgs / Hr
LATENT HEAT OF VAPORISATION OF ETHYL ALCOHOL			204	K Cal / Kg.
TOTAL HEAT LOAD WILL BE -	m *L	=	**55324.8**	K Cal / Hr

2 WATER

MASS LOAD			20.89	Kgs / Hr
LATENT HEAT OF VAPORISATION OF WATER			550	K Cal / Kg.
CONSIDERING AROUND 20% OF MOISTURE WILL BE EVAPORATED				
IN DRYER #1 THE MOISTURE LOAD IN DRYER #1			4.178	Kgs / Hr
TOTAL HEAT LOAD WILL BE -	m *L	=	**2297.9**	K Cal / Hr

HENCE TOTAL HEAT LOAD REQUIRED IN DRYER #1 WILL BE		69622.7	K Cal / Hr
		80.96	Kw
	SAY	**90**	**Kw**

EXCLUDING LOSSES ,AND HEAT LOAD OF DRYER ASSEMBLY AND SUPPORTING STRUCTURE.

DRYER # 2

THE MAJOR HEAT LOAD WILL ONLY MOISTURE. PLUS ANY SENSIBLE HEAT REQUIRED

TO RECUPERATE THE LOSS IN SENSIBLE HEAT DURING THE TRANFER FROM DRYER #1 TO # 2.

1 SENSIBLE HEAT :

    1   PROTEINS , CARBOHYDRATES ,ASH

SPECIFIC HEAT		0.45	K Cal / Kg.^{0}C	
MASS LOAD		157.91	Kgs / Hr	
TEMPARATURE	INITIAL	45	^{0}C	(ASSUMED)
	FINAL	72	^{0}C	
	Δt	27	^{0}C	
HEAT LOAD	m*Cp*Δt		**1918.61**	K Cal / Hr

2 LATENT HEAT :

    1 <u>WATER</u>

MASS LOAD		20.89	Kgs / Hr
DESIRED MOISTURE LEVEL IN THE FINAL PRODUCT AT 6%		9.47	Kgs / Hr
MOISTURE LOAD IN DRYER #2		11.42	Kgs / Hr
LATENT HEAT OF VAPORISATION OF WATER		550	K Cal / Kg.
TOTAL HEAT LOAD WILL BE -	m *L	= 6278.47	K Cal / Hr

HENCE TOTAL HEAT LOAD REQUIRED IN DRYER #1 WILL BE   8197.08   K Cal / Hr

    9.53   Kw

    <u>SAY</u>   <u>**12**</u>   **Kw**

COOLING CHAMBER :

THE FINAL PRODUCT COMING OUT FROM THE DRYER #2 WILL BE AT MAX 75 ^{0}C

THIS PRODUCT TO BE COOLED TO AMBIENT TEMPARATURE BY NITROGEN / AIR.

THE INPUT TEMPARATURE OF GAS ASSUMED WILL BE AROUND 15 ^{0}C

THE HEAT TO BE REMOVED WILL BE -

TOTAL MASS OF FINAL PRODUCT -			167.38	Kgs / Hr
TEMPARATURE	INITIAL	75	^{0}C	
	FINAL	30	^{0}C	
	Δt	45	^{0}C	
SPECIFIC HEAT		0.45	K Cal / Kg.^{0}C	
HEAT LOAD	m*Cp*Δt		3389.54	K Cal / Hr
			3.94	Kw
		SAY	**5**	**Kw**

NOTES :

1 **DRYER # 1 :**

    A.   THE FEED IS HEAT SENSITIVE.

    B.   THE SYSYTEM TO BE UNDER VACUUM DURING DRYING OPERATION.

FOR THIS TYPE DRYING PROCESS THE BEST TYPE OF DRYER RECOMENDED IS

ROTARY VACUUM PADDLE TYPE DRYER.

IN THIS SYSTEM EVEN SHAFTS AND PADDLE CAN BE USED FOR HEAT TRANSFER.

ALSO WITH VARIABLE SPEED DRIVE THE AGITATION / MIXING CAN BE CONTROLLED

TO SUIT THE PROCESS CONDITION.

IN THIS PARTICULAR PROCESS AS THE TOTAL HEAT LOAD IS HIGH AND THERE IS RESTRICTION

ON THE OPERATING TEMPARATURE , ONE DRYER MAY NOT BE SUFFICIENT.MULTIPLE DRYERS

IN PARALLEL OPERATION CAN BE CONSIDERED.

FOR HEATING MEDIUM HOT WATER AROUND 80 - 85 ^{0}C IS BEST SUITED.

2 **DRYER # 2 :**

THIS DRYER CAN BE CONTINUOUS BELT / BAND TYPE.WITH HOT NITROGEN AS

HEATING / VENTING MEDIUM.ONLY ONE NUMBER WILL BE SUFFICIENT

AS THE FEED MASS AND HEAT LOAD ARE VERY LESS COMPARED TO DRYER #1.