It sounds that TCC has set Mach number of 0.1 as the criterion in order to have noise level within reasonable limits. Furthermore, Implant and Aspen Flarenet results are compared which shows good Compatibility.

Also, the deviation might stem from different composition because in absence of exact composition, MW Of each source were given to Aspen Flarenet and aspen flarenet estimates the composition.

Flare K.O.D Sizing

1.Knockout drums are typically located on the main flare line upstream of the flare stack or any liquid seal. If there are particular pieces of equipment or process units within a plant that release large amounts of liquid to the flare header, it is desirable to have knockout drums inside the battery limits to collect these liquids. This reduces the sizing requirements for the main flare knockout drum, as well as facilitates product recovery.

2. The economics of drum design can influence the choice between a horizontal and a vertical drum. If a large liquid storage capacity is desired and the vapor flow is high, a horizontal drum is often more economical. Also, the pressure drops across horizontal drums is generally the lowest of all the designs. Vertical knockout drums are typically used if the liquid load is low or limited plot space is available. They are well suited for incorporating into the base of the flare stack.

3. Among disparate configurations proposed in API-527, a combination of a vertical drum in the base of the flare stack and a horizontal drum upstream to remove the bulk of the liquid entrained in the vapor has been selected for MEKPCO. Horizontal drum with the vapor entering one end of the vessel and exiting at the top of the opposite end (no internal baffling);

4.A split-entry or split-exit configuration can be used to reduce the drum diameter (but increase the length) for large flow rates and should be considered if the vessel diameter exceeds 3.66 m (12 ft). Careful consideration should be given to the hydraulics of split-entry configurations to ensure the flow is indeed split in the desired proportion. Inlet nozzles should include means such as baffles or long sweep elbows to prevent re-entrainment of liquid. Long sweep elbows are typically used up to DN 300 (NPS 12) inlet diameter. Baffles are typically used for larger inlet diameters. Neither of these rules has been applied for MEKPCO application.

5. In general, vapor outlet nozzles should not be fitted with any devices (e.g. deflection plates, baffles, demister pads, vane packs, etc.), because of the potential for such devices to fail or plug and obstruct the outlet. Such devices should be used only if the drum is equipped with an alternate outlet nozzle sized for the drum's design vapor flow rate and fitted with a rupture disk (or pin-actuated device) whose burst pressure is selected both to protect the drum against overpressure and to permit proper operation of the drum and relief system in the event the normal vapor outlet becomes obstructed.

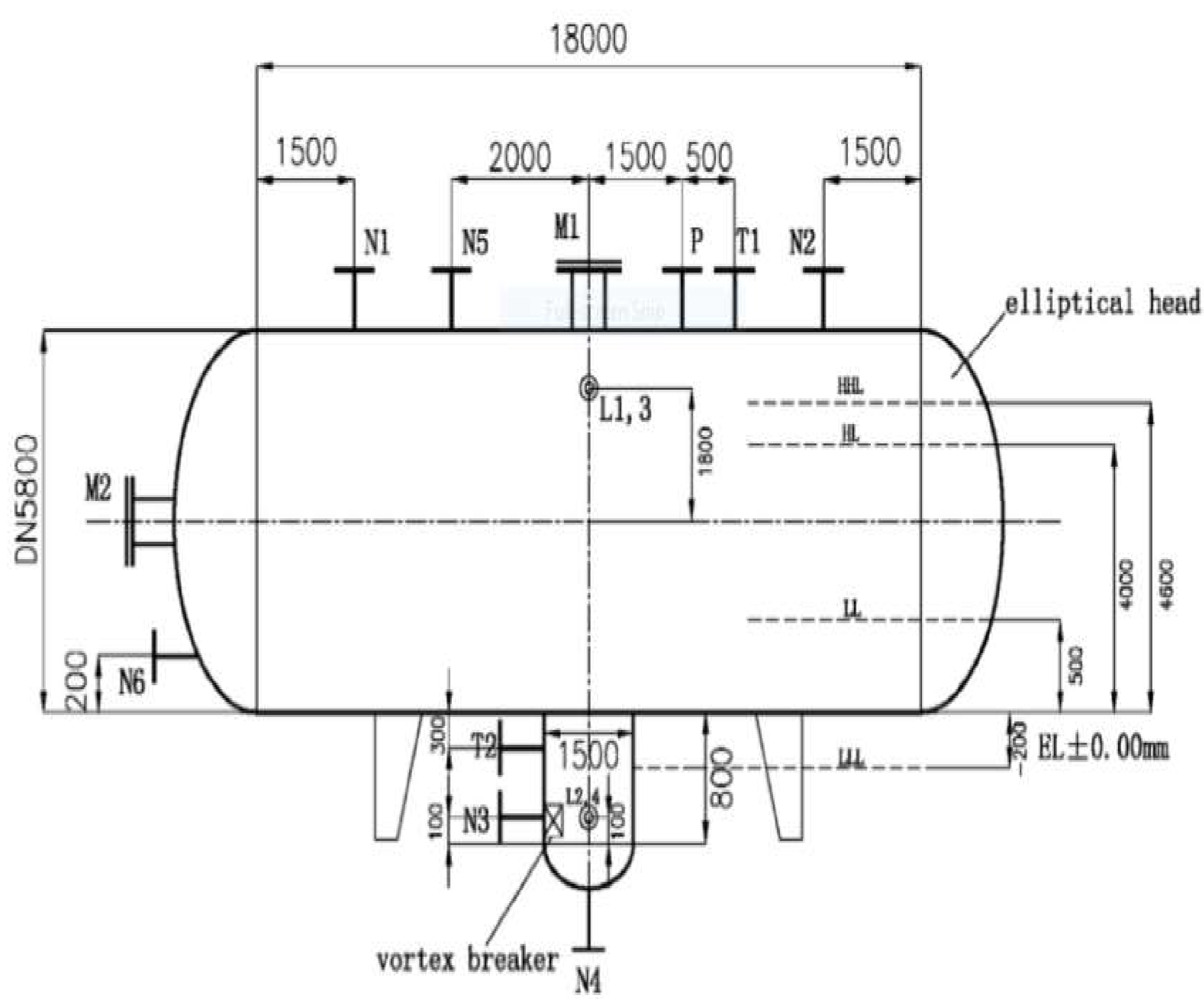
6. Liquid droplets 300 um and larger may drop out of the gas stream at less than 2 m/s. If liquids are not drained from the system, flare flows with gas velocities exceeding about 3 m/s or 4 m/s can entrain liquid droplets up to 1000 μm in size. Liquid droplets exceeding 1000 μm can readily lead to burning rain regardless of flare type.

7. Among different flare burner types alluded to in API-527 steam and air-assisted flare burner has been selected for MEKPCO project. For this design, Flare gases containing less than 1 % by mass of liquids up to a liquid droplet size of 600 μm can be handled smokeless and without burning rain. Some air assisted burners with small ports and operated at significant pressures can handle larger amounts, and with larger droplet size, without smoke.

8. The liquid holdup capacity of a flare knockout drum is based on consideration of the amount of liquid that can be released during an emergency situation without exceeding the maximum level for the intended degree of liquid disengagement. The holdup times vary between users, but the basic requirement is to provide sufficient volume for a 20 min to 30 min emergency release. Longer holdup times might be required if it takes longer to stop the flow. This holdup should also consider any liquid that can have previously accumulated within the drum that was not pumped out. If there has been a liquid discharge to the knockout drum whereby the liquid level exceeds the maximum level required for adequate vapor-liquid separation, then liquid shall be removed to reduce the level back below this maximum level.

9. It is important to realize as part of the sizing considerations that the maximum vapor release case might not necessarily coincide with the maximum liquid. Therefore, the knockout drum size

should be determined through consideration of both the maximum vapor release case as well as the release case with the maximum amount of liquid. If no valid liquid case exists and the vapor is either condensable or has a condensable component, then the design liquid case should be a minimum of 2 wt. % of the maximum gas rate to the flare knockout drum.



1st Step: Nozzle Sizing

The criterion for inlet nozzle sizing is velocity limitation which should be 7-13 m/s.

The criterion for gas outlet nozzle sizing is velocity limitation which should be 15-30 m/s.

The criterion for inlet nozzle sizing is velocity limitation which should be 2-4 m/s.

Parameter	Inlet Nozzle	Gas Outlet Nozzle	Water Outlet Nozzle
Mass	**540000 kg/h**	**510000 kg/h**	**30000 kg/h**
Density		**6.82 kg/m3**	**988 kg/m3**
Qv	**20.25m3/s**	**20.24 m3/s**	**0.01 m3/s**
ID-TCC	**64’**	**72’**	**4’**
Velocity	**9.76 m/s**	**7.7 m/s**	**1.04 m/s**
My ID	**64’**	**64’**	**3’**
Velocity	**9.76 m/s**	**9.76 m/s**	**1.85 m/s**

Note that according to API-521, when there is no criterion stipulating the exact amount of water which should be separated a minimum of 2% by weight of total vapor mass could be selected as basis for calc.

But TCC has assumed 30000 m3/h as the rated capacity of K.O.D pump which is Another matter is that the vendor has selected 72’ as outlet nozzle ID which is a bit bigger than what the criterion stipulates. Perhaps the vendor was more concerned with droplet sizing so that the higher the outlet nozzle ID, the lower particle sizing. Probably maximum 300 um has been taken for Design Basis.

2nd Step: K.O.D Diameter and Length Sizing

1. Assume Diameter and consider L= 2.5 or 3 D

2. Calculate AL and AT according to the following equation:

AL = Q.t/ (L.N)   AT = Π(D^2)/4   t = Hold-up time

3. Calculate AL/AT and calculate hL/D from the following equation:

$A_L/A_T=(\theta - \sin\theta)/(2\pi)$ and $\theta = 2\arccos(1-2h_L/D)$, θ in radians

4. Calculate hV = D. (1 – hL/D)

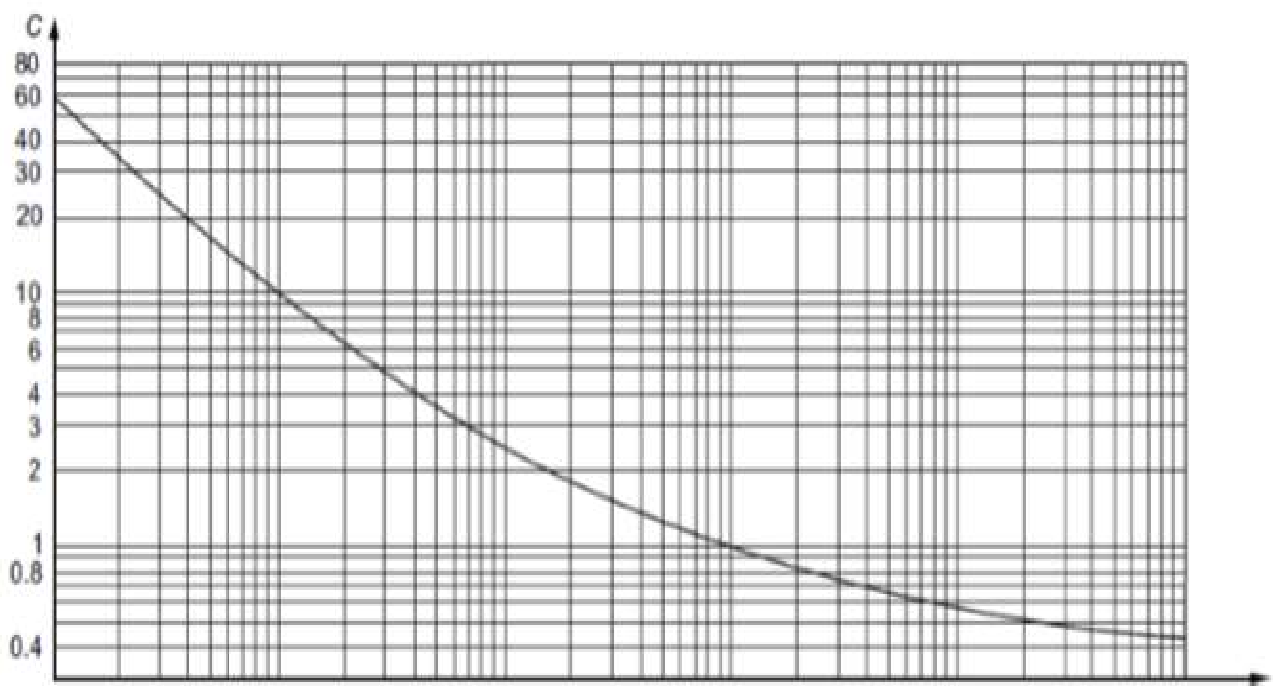
Parameters	Values
Vapor mass kg/h	**510000**
Liquid mass kg/h	**30000**
ρv Kg/m3	**6.8**
ρl Kg/m3	**990**
Dp um	**300**
Hold-up time minute	**30**
L/D	**3**
D meter	**3.5**
L meter	**10.5**

5.Calculate uc by following equation:

$$u_c = 1.15\sqrt{\frac{g \times D(\rho_l - \rho_v)}{\rho_v \times C}}$$

where

- g is the acceleration due to gravity [= 9.8 m/s^2 (32 ft/s^2)];
- D is the particle diameter, expressed in m (ft);
- ρ_l is the density of the liquid at operating conditions, expressed in kg/m^3 (lb/ft^3);
- ρ_v is the density of the vapor at operating conditions, expressed in kg/m^3 (lb/ft^3);
- C is the drag coefficient (see Figure 5).



6. Calculate φ = hv/uc
7. Calculate AV = AT-AL
8. Calculate Uv = Qv / (Av.N)
9. Calculate Lreq = Uv. φ .N

Parameters	Value
AL	**1.44**
AT	**9.62**
AL/AT	**0.15**
hL/D	**0.21**
ERROR	**Goal Seek Function**
hV/D	**0.79**
hV	**2.77**
Uc	**0.75**
φ	**3.7**
AV	

Parameters	Value
Uv	**2.55**
Lmin m	**9.42**
Inlet ID inch	**64**
Outlet ID inch	**72**
LT	**14.6**

If initial volume is not zero and is about 50 m3

Parameters	Value
AL	6.2
AT	9.62
AL/AT	0.64
hL/D	0.61
ERROR	Goal Seek Function
hV/D	0.39
hV	1.35

Parameters	Value
Uc	**0.75**
φ	**1.8**
AV	**3.42**
Uv	**6.1**
Lmin **m**	**10.98**
Inlet ID **inch**	**64**
Outlet ID **inch**	**72**
L	**10.5**

10.Verification: If L_{Req} is greater than L, increase the drum diameter and repeat the L_{Req} calculations again until L_{Req} is less than L. Also, hl/D should be max 0.5.

Since L_{Req} is less than L then, we ought to increase K.O.D ID to 4 meter and repeat the procedure.

So for doing this, we use Goal seek function in Excel to help us reach exact point of hL/D.

Parameters	Value
D	4
L/D	3
L	12
Uc	0.75

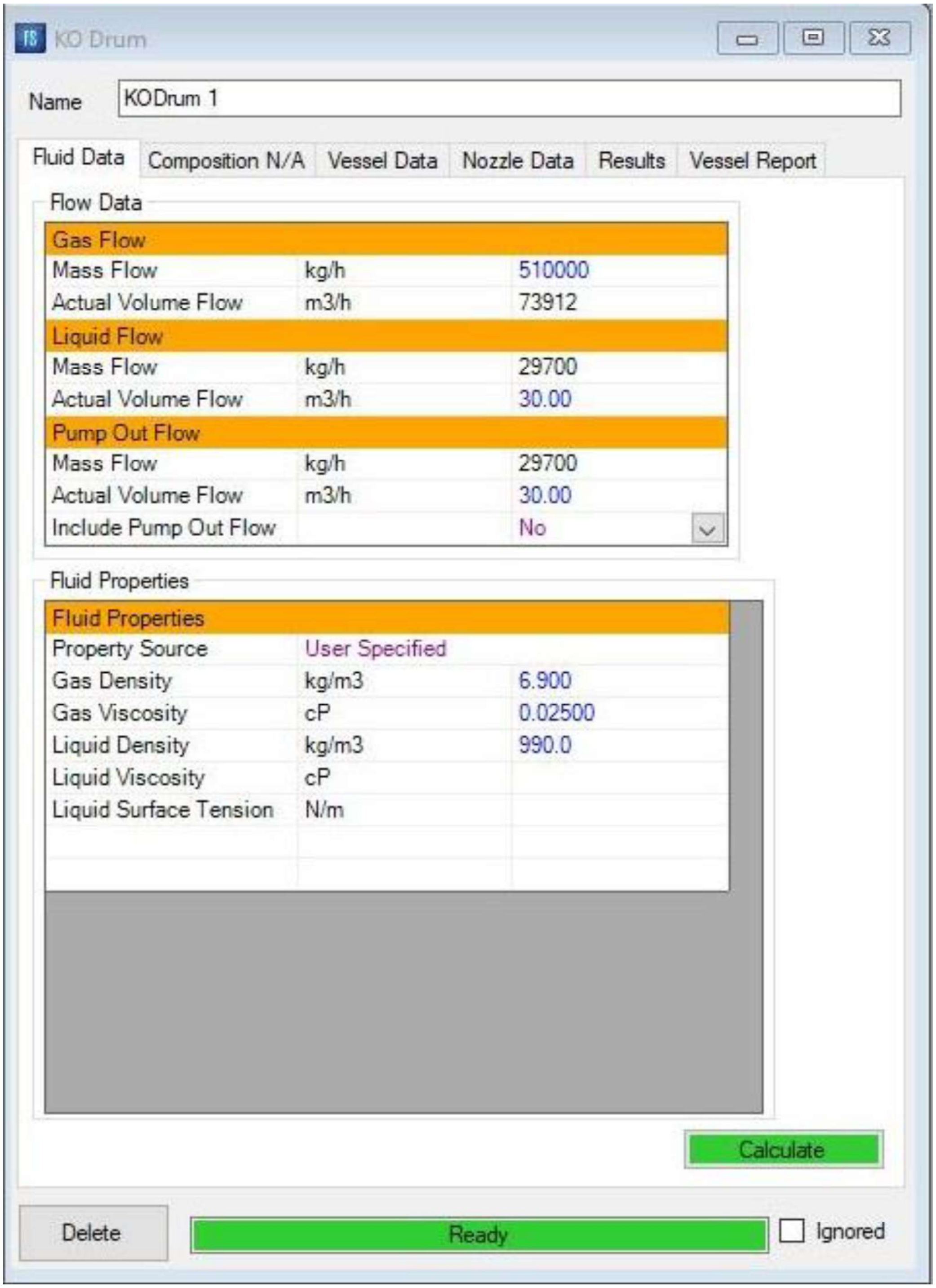
Parameters	Value
AL	5.43
AT	12.57
AL/AT	0.43
hL/D	0.44
ERROR	Goal Seek Function
hV/D	0.55
hV	2.21

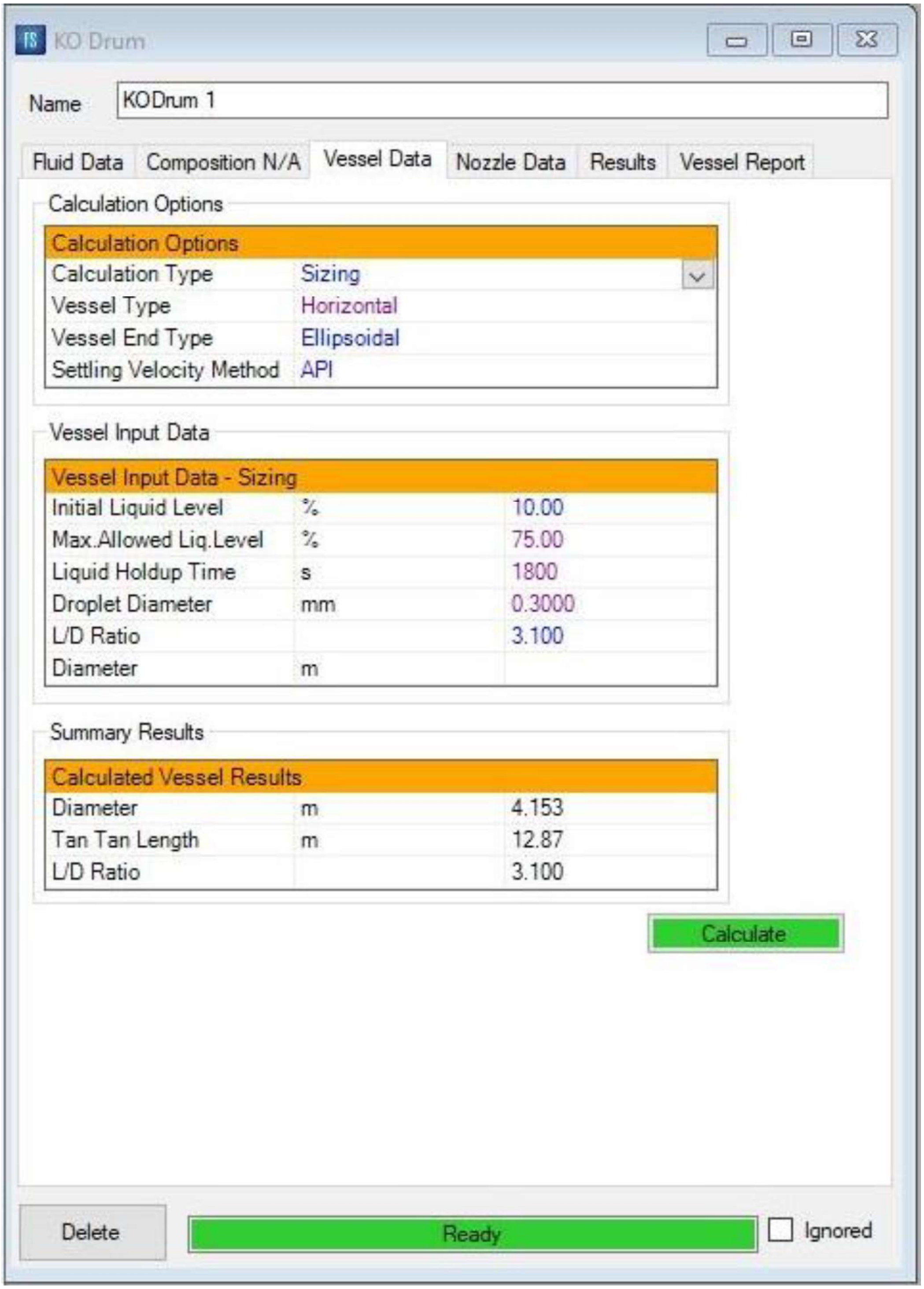
Parameters	Value
φ	2.95
AV	7.14
Uv	2.92
Lmin m	8.62
Inlet ID inch	64
Outlet ID inch	72

TCC has ordered a K.O.D with the following sizing which is oversized in my opinion but appears to be good in handling such amount of gas and condensate.

Parameters	TCC	API-521	Sabalan
Diameter	5.8 m	4 m	5m
Length	18 m	14 m	10m

Flaresim Design




KO Drum
Name
KODrum 1
Fluid Data
Composition N/A
Vessel Data
Nozzle Data
Results
Vessel Report
Calculation Options
Calculation Options
Calculation Type
Sizing
Vessel Type
Horizontal
Vessel End Type
Ellipsoidal
Settling Velocity Method
API
Vessel Input Data
Vessel Input Data - Sizing
Initial Liquid Level
%
10.00
Max.Allowed Liq.Level
%
75.00
Liquid Holdup Time
s
1800
Droplet Diameter
mm
0.3000
L/D Ratio
3.100
Diameter
m
Summary Results
Calculated Vessel Results
Diameter
m
4.153
Tan Tan Length
m
12.87
L/D Ratio
3.100
Calculate
Delete
Ready
Ignored