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Experimental investigation of inlet vane design and performance in hydrocarbon systems

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Abstract

Separation efficiencies for a scrubber inlet vane section was investigated using a natural gas hydrocarbon system at 20, 50 and 85 bars. Several design features were investigated such as diameter of inlet pipe, vane design, separator vessel diameter. In addition the effect of liquid rate was examined. The study finds that pipe diameter, column diameter, liquid rate and fluid properties of the inlet vane affect separation efficiencies. This is a result of several different fluid mechanical processes which affect the droplet size distribution into the separation vessel.

Keywords: Multiphase flow, Re-Entrainment, Breakup, Scrubber, Inlet vane, Souder Brown equation

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1. Introduction

An Inlet vane is used in separation devices with high gas loading, typically above a GVF of 0.7. The purpose of an inlet vane is to distribute the gas and liquid evenly into the separation device and thus achieve good gravity separation of droplets. Inlet vanes are used in both horizontal and vertical separation vessels as well as knock-out drums. For vertical separation vessels the Inlet vane is the first step for achieving good separation performance, usually one or two additional devices are used for gas cleaning, see Figure 1. The majority of vertical separators have a diameter of 1-3 meters. A typical configuration used in the oil and gas industry is an Inlet vane, mesh pad and an Axial flow cyclone deck. This type of configuration uses three different separation principles, gravitational settling, Inertial impaction and centrifugal separation for removing droplets from the gas stream, see Setekleiv and Svendsen [16],Setekleiv and Svendsen [17], Setekleiv et al. [18] and Austrheim [1] for details. The gravitational settling section will separate the biggest droplets. Subsequently the 1st step, the mesh pad, will separate smaller droplets typically down to 10 μm.

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The 2nd step, the axial flow cyclone, typically separates droplets down to 3 μm. However, depending on the required cleanliness of the gas in the gas outlet or the droplet size distribution in the separator inlet there are more combinations of separator internals that may be used. It is possible to use vane packs, as both a 1st or 2nd stage separator internal, combined with a mesh pad. When the mesh pad acts a 1st stage separator it may operate as a coalescer feeding big droplets for separation in the vane pack. When the vane pack acts a 1st stage separator it will separate big droplets and the mesh pads will separate the smaller droplets. It is also possible to install two different mesh pads with different properties to achieve a two stage droplet separation.

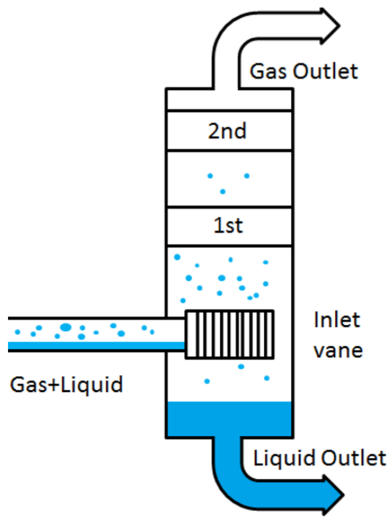

Figure 1: Layout of a scrubber with Inlet vane and two separator units installed.

1.1. Droplet mechanics

In order to grasp the subtleties of inlet vane performance a good grasp of droplet fluid mechanics is needed. There are many phenomena and fluid mechanical processes that influence the separation efficiency in an inlet vane in conjunction with the gravitational settling zone in separation device, such as:

- Gravitational settling of droplets
- Droplet breakup
- Breakup of liquid sheets and jets
- Droplet re-entrainment
- Droplet coalescence
- Inertial capture of droplets

In order to examine the effect of gravitational settling of droplets across different fluids the K-value is used, Souders and Brown [20]. A constant K-value for turbulent flows systems with different fluid properties implies that the maximum droplet size that can gravitational settle is the same. However, the droplet size distribution evolves from the inlet pipe, through the inlet vane, and into the column and thus the K-value alone cannot determine the gravitational separation performance.

The droplet size distribution may be affected by several processes resulting in the creation of droplets skewing the distribution towards smaller or larger droplets. Droplets may be created when droplets re-entrain from a liquid film into the gas core as discussed in Austrheim et al. [2], Patruno et al. [14], Ishii and Grolmes [9] and Kataoka et al. [10]. Re-Entrainment may be seen as a balance of inertial forces acting on a liquid film compared to its surface tension. Thus, increasing gas velocity, reducing surface tension or increasing liquid film height will in general increase the amount and affect the size of droplets leaving a liquid film.
When liquid protrudes from an inlet vane it may be in the form of liquid sheets or jets as presented by Eggers and Villermaux [6], Lin [11] or Marmottant and Villermaux [12]. Low surface tension, high gas velocity or low liquid flow will promote the breakup of these sheets and jets. In addition these phenomena has to evolve in time before breakup occurs. This characteristic breakup time will decrease with smaller sheet or jet thickness.

After a droplet is Re-entrained or a sheet or jet has broken up into droplets they may also be subject to additional breakup due to turbulence. For droplet breakup to occur it has to collide with an eddy. Increasing velocity of the continuous phase will increase turbulent intensity and number of eddies thus increasing the Eddy drop collision frequency, Hagesæther [7]. This will result in more droplets breaking. Decreasing surface tension will also increase the probability of droplets breaking up leading to a shift in the droplet size distribution towards smaller droplet sizes.

The droplet size distribution may also be affected by processes that remove droplets from the distribution such as droplet coalescence and inertial impaction. Droplet coalescence occurs when two droplets collide and the contact time between the two colliding droplets is sufficient for film drainage of the liquid film between the two drops, Coulaloglou and Tavlarides [5]), Chesters [4]. In general droplet coalescence events increase with increasing volume fraction, lower surface tension and low gas velocities.
Inertial impaction occurs occurs when droplets have sufficient inertia to impact the blades of the inlet vane or hit a column wall. Typically when the characteristic diameter of the target is reduced, or density difference between gas and liquid phase is increased the probability of droplet impaction events increases. Droplet impaction is characterized by the Stokes number, Chen [3].

2. Experimental apparatus

The experiments were conducted in a rig constructed for high pressure operations up to 100 bars, see section 2.1. Separation efficiency was measured 410 mm above the inlet vane. Four different inlet vanes were tested with corresponding inlet tube, described in section 2.4. The test columns are scaled down vertical separators. It is expected that separation efficiencies in such a setup are better than their industrial scale counterparts. The effect of scaling is discussed in section 4.2 comparing the two test columns.

2.1. High pressure rig

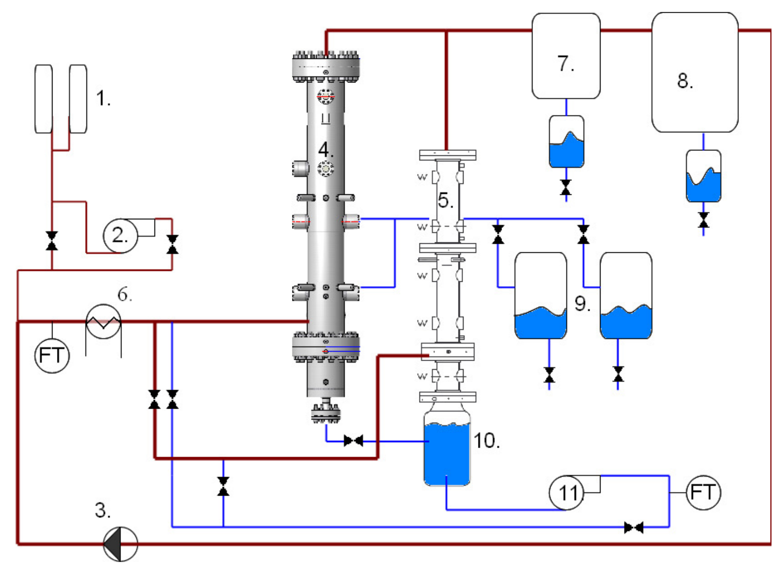

Figure 2: Layout of the experimental apparatus: — Main gas flow — Liquid flow **1.** Gas bottles **2.** Gas booster **3.** Gas circulator **4.** 252 mm test column **5.** 150 mm test column **6.** Heat exchanger **7.** Scrubber w/meshpad **8.** Scrubber w/meshpad **9.** Drain tanks **10.** Liquid reservoir **11.** Liquid piston pump

The experimental setup, as shown in Figure 2, consisted of two test columns with inner diameters of respectively 150 mm, (Figure 2 number 4.), and 252 mm, (Figure 2 number 5.). The two columns were connected to two internal circulation loops, one for gas and one for liquid flow. A gas circulation fan ensured a continuous circulation of the gas medium. The fan was immersed in a glycol bath to ensure temperature control and steady operation. The liquid was pumped by two piston pumps and injected through a nozzle 1.4 m upstream of the column gas inlet. It was also possible to pump liquid into the nozzle from

two drain tanks, number 9., using impeller pumps. To ensure that all liquid inside the circulation loop could be re-used, two scrubbers (Figure 2, number 7. and 8.) were placed downstream of the test columns. This ensured that all liquid not separated by the column could efficiently be separated out and pumped back into the into the reservoir(Figure 2,number 10.). The liquid separated out in the 252 mm test column was directly drained into the reservoir. The rig was placed inside a container with climate control and was operated from a remote control room. The temperature of the rig was set to 20^oC. Climate control ensured that the temperature between the room and process did not exceed 0.5^oC.
The gas and liquid flows were monitored using two Coriolis flow meters, one for high gas flows (0-2268 kg/min) and one for low gas flows(0-227 kg/min). The accuracy of both was 0.1 % of total span. The 252 mm column was connected to three double block and bleed valves. This was done so that mechanical work on the rig could be implemented without the need for de-pressurization and liquid drainage of the whole system.The geometry of the 150mm column was described by Austrheim [1].

2.2. Funnel cap

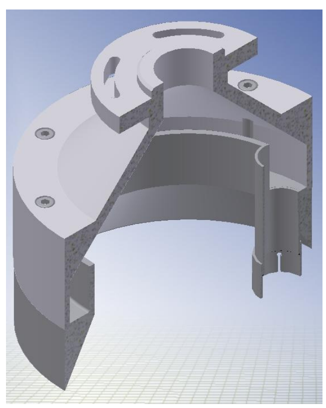

Figure 3: Schematic of funnel cap.

In order to investigate separation efficiency of the column at different heights, a hydraulic cylinder, see section 7.5, was made that was mounted on top of the 252 mm column. The hydraulic tube was connected to a funnel cap, see Figure 3, which could slide inside the 252 mm column. The clearance from the funnel cap to the column wall was 0.5 mm. The funnel cap was also able to collect liquid at the rim of the cap. A skirt was made to collect liquid, Figure 3, which was connected to a telescope pipe that could slide along with the funnel cap. This allowed for drainage from the liquid collected by the skirt and drained to tank 9. A magnetostrictive level transmitter was used to log the position of the funnel cap. In these investigations the funnelcap height and cylinder was kept constant at 410 mm above the inlet vane as this is the distance at which the mesh pad is mounted in the most common scrubber setup, inlet vane, wire mesh-pad and cyclone deck.

In the 150 mm column a reducer was made with the same shape as the funnelcap. No skirt or telescope couplings were made due to the small dimensions of the 150 mm column. The reducer was placed 410 above the inlet vane.

2.3. Fluid properties

An artificial Natural gas mix(NG) was used. The Natural gas was a three component mixture consisting of 85 mole% methane and 15 mole% ethane saturated with pentane. Approximately 62 kg of pentane was used to fill the rig. The methane/ethane mixture was premixed on a regiment of gas bottles to the required pressure. When the gas and liquid had been filled into the rig the fluids were circulated to obtain equilibrium between the gas and liquid phase. Since all the pentane was filled initially and only methane and ethane are added, the fluid composition varies with pressure, the fluid becoming lighter with increasing pressure.

Table 1: Properties of fluid systems in HP-rig.

P	System	ρ_g	ρ_l	σ_{lg}	μ_g	μ_l
$[bar]$	$[-]$	$[\frac{kg}{m^3}]$	$[\frac{kg}{m^3}]$	$[\frac{N}{m}]$	$[Pas]$	$[Pas]$
20	NG	17.7	602	0.0131	$1.12 \cdot 10^{-5}$	$2.07 \cdot 10^{-4}$
50	NG	45.9	550	0.0074	$1.21 \cdot 10^{-5}$	$1.49 \cdot 10^{-4}$
85	NG	88.1	486	0.00293	$1.40 \cdot 10^{-5}$	$1.03 \cdot 10^{-4}$

To calculate the properties of the fluid systems the Soave-Redlich-Kwong equation of state, Soave [19], with the Peneloux correction,Peneloux and Evelyne [15] was used. Interfacial tension was calculated by the method of Weinaug and Katz [21]. This is the same procedure as described by Austrheim [1]. A summary of the properties is given in Table 1.

2.4. Inlet vane design

NORSOK [13] requires that the inlet pipe momentum does not exceed 6000 Pa. The reference inlet momentum in the inlet pipe, ID=62.7 mm, at a K-value of 0.20 m/s was just below this criterion at 20 bars. In addition two inlet pipes were designed so one exceeded the Norsok standard and one was below 6000 Pa, see Figure 4.To assure good inlet conditions and an even distribution of liquid into the scrubber an inlet vane for each inlet pipe is designed with an expansion factor, $A_{vane}/A_{pipe} = 4$. The vanes were placed in the middle of the 252mm column. The inlet vane designs are give in the appendix 7.4. For the Inlet vane in the 150mm column see Austrheim [1]. Figure 5 gives a representation of parameters relevant for inlet vane design, a summary of these parameters are

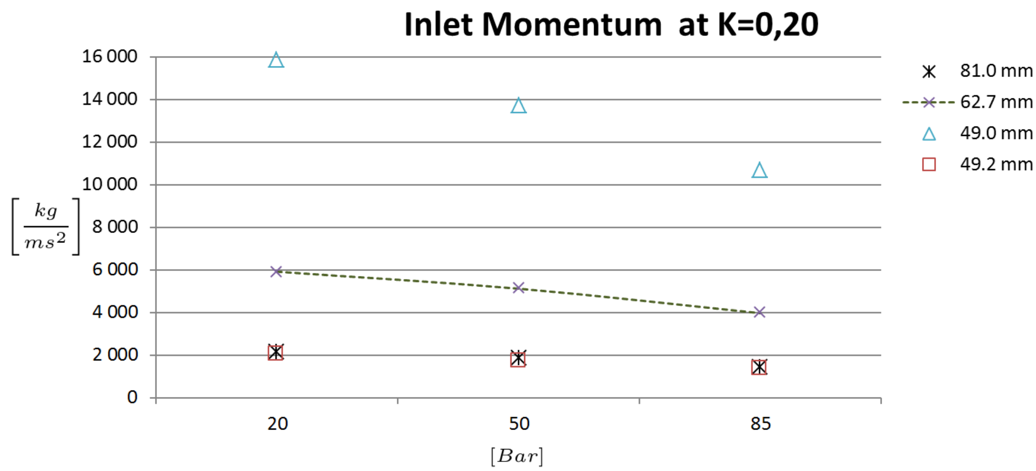

Figure 4: Inlet momentum at different pressures for different inlet pipes at a K-value of 0.20 m/s. The 49.2 mm pipe was used in the 150 mm column.

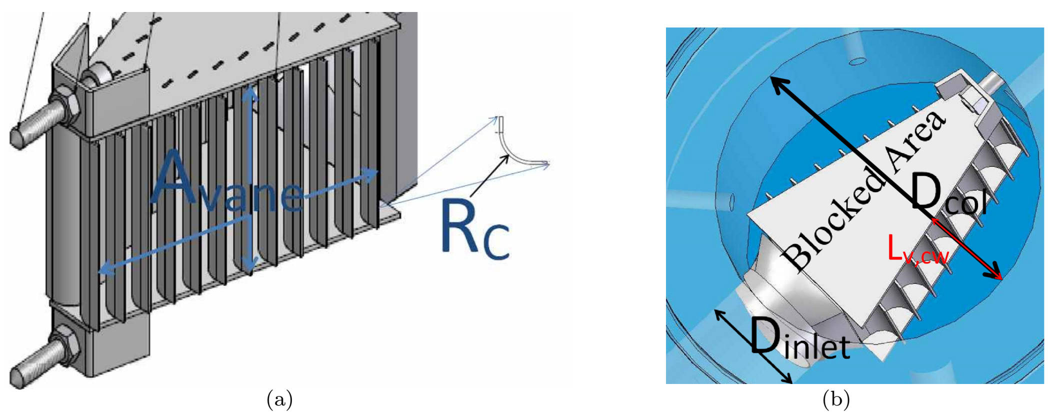

Figure 5: Geometrical aspects of an inlet vane. Blocked area is the area occupied by the inlet vane and the inlet pipe inside the scrubber column. D_{col} is the inner diameter of the column and D_{inlet} is the inlet pipe inner diameter. R_c is the characteristic radius of the vanes. A_{vane} is the vane area, here only half of the total area is shown. $L_{v,cw}$ is the distance from the middle of the inlet vane to the column wall.

given in Table 2.

The inlet vanes were connected to an inlet pipe, the inlet pipe configuration is shown in Figure 6. Here a nozzle shoots liquid counter currently into the gas flow. The gas flow goes through the T-section shown in Figure 6 and thus makes a turn prior to entering the inlet pipe and nozzle setup.

In addition a comparison was performed with the 62.7 mm inlet pipe and a

Table 2: Properties of inlet vanes and designation of different inlet vane configurations.

Inlet vane properties						
$Vane\ configuration$		V	W	X	Y	Z
D_{col}	$[mm]$	252	252	252	252	150
D_{inlet}	$[mm]$	81	62.7	62.7	49	49.2
A_{vane}	$[mm^2]$	20671	20671	12511	7668	9615
$Expansion\ factor$	$[-]$	4	6.7	4.1	4.1	5.4
$Velocity\ ratio{=}D_{col}^2/D_{inlet}^2$	$[-]$	9.7	16.2	16.2	26.4	9.3
R_c	$[mm]$	10	10	7.8	6	9
$L_{v,cw}$	$[mm]$	91.4	91.4	99.2	105	49.8
$BlockedArea$	$[\%]$	37.4	37.4	23.4	21.9	39.5

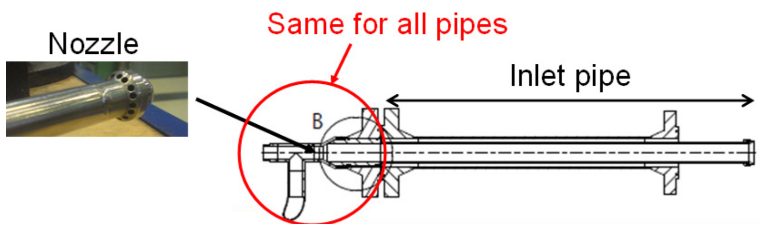

Figure 6: Installation of inlet pipe. First section is the same for all configurations. The arrows in black shows a representation of the length of the different inlet pipes installed. These pipes go through the scrubber column wall and into the respective inlet vanes.

different expansion factor of 6.7, this was the same inlet vane used for the 81mm inlet pipe. A comparison of experiments performed in a smaller test column, $D_{col} = 150mm$, was also made to deduce some of the effects of column geometry upon separation efficiency. The properties of these inlet vanes are also given in Table 2.

3. Separation efficiencies and uncertainties

The calculation of separation efficiency in the High pressure rig is shown in Eq.(1). The expression above the fraction line represents how much liquid is transported out of the scrubber test columns and the expression below the fraction line is the amount of liquid entering the scrubber test columns, see Figure 2.

$$Efficiency = 100 - 100 \cdot \left(\frac{\dot{m}_{78} + \frac{\partial m_7}{\partial t} + \frac{\partial m_8}{\partial t} + \frac{\partial m_9}{\partial t}}{\dot{m}_{9a} + \dot{m}_{9b} + \dot{m}_{11}} \right) \tag{1}$$

Where $\dot{m}$ represents the mean of measurements taken by several Coriolis flow meters in the rig, given in kg/s. $\frac{\partial m}{\partial t}$, or slope, is the linear fit of the differential pressure transmitter connected to the specific drain-tank. The liquid height is a function of the pressure drop. The total measurement uncertainty may be described as:

$$Total\ uncertainty = \sqrt{(Instrument\ uncertainty)^2 + (Repeatability\ uncertainty)^2} \quad (2)$$

Where the repeatability uncertainty was found to be 5.58 % of liquid carryover. The uncertainty for each test-point is given in Table 3, 4, 5,6 and 7. The total uncertainty was 5.73 % of liquid carryover.

4. Results

All experiments were conducted with the funnel cap arrangement, see section 2.2, at a position 410mm above the inlet vane. Liquid fractions of 0.2, 0.5, 1.0 Vol% and 250 kg/hr were used at K-values of 0.07, 0.10, 0.12, 0.15, 0.17 and 0.20 m/s.

For all comparison of the experimental results the K-value in the separation vessel is used as this will evaluate the effect of the gravitational settling of droplets in the column setup. The inlet vane and piping into the separator column will determine much of the droplet size distribution into the gravitational settling zone and this will directly effect the separation efficiency of the separation. The inlet arrangement will also determine how much of the liquid is distributed as a liquid film or as droplets suspended in the gas flow going into the separator column. In order to investigate the effect of inlet vane and associated pipe several parameters of design was investigated such as the effect of increasing liquid fraction, the effect of increasing pressure, the effect of changing pipe diameter and the effect of changing vane design but keeping the the ID of the inlet pipe constant. A discussion on Inlet momentum is also given.

4.1. The effect of Vane design with constant ID inlet pipe

Figure 7 shows the results of using the same inlet pipe diameter of 62.7 mm and different expansion factor/ Characteristic radius at a liquid fraction of 0.5 vol%. This comparison is also valid at 0.2 vol%. At 1.0 vol% and 250 kg/hr there are too few data points to make a good comparison, see Figure 13. Figure 7 shows that increasing the expansion factor does not have a large effect upon separation efficiencies. At 20 bars there is no clear effect of expansion factor. At 50 and 85 bars there seems to be a consistent trend of vane design as the inlet vane designed with an expansion factor of four show a slightly better separation efficiency compared with the vane with an expansion factor of 6.7. This could be an effect of smaller characteristic radius of the vanes in this configuration, $R_c = 7.8mm$, while the vane with the highest expansion factor has a characteristic radius, $R_c = 10mm$. The droplet size distribution and liquid film distribution in the two configurations should be more or less the same at the same column K-value. The Stokes number is slightly higher for the vane with an expansion factor of 4. The higher Stokes number indicates that this vane is able separate smaller droplets compared with the larger radius vane with expansion factor of 4. However, the trend may not be statistically

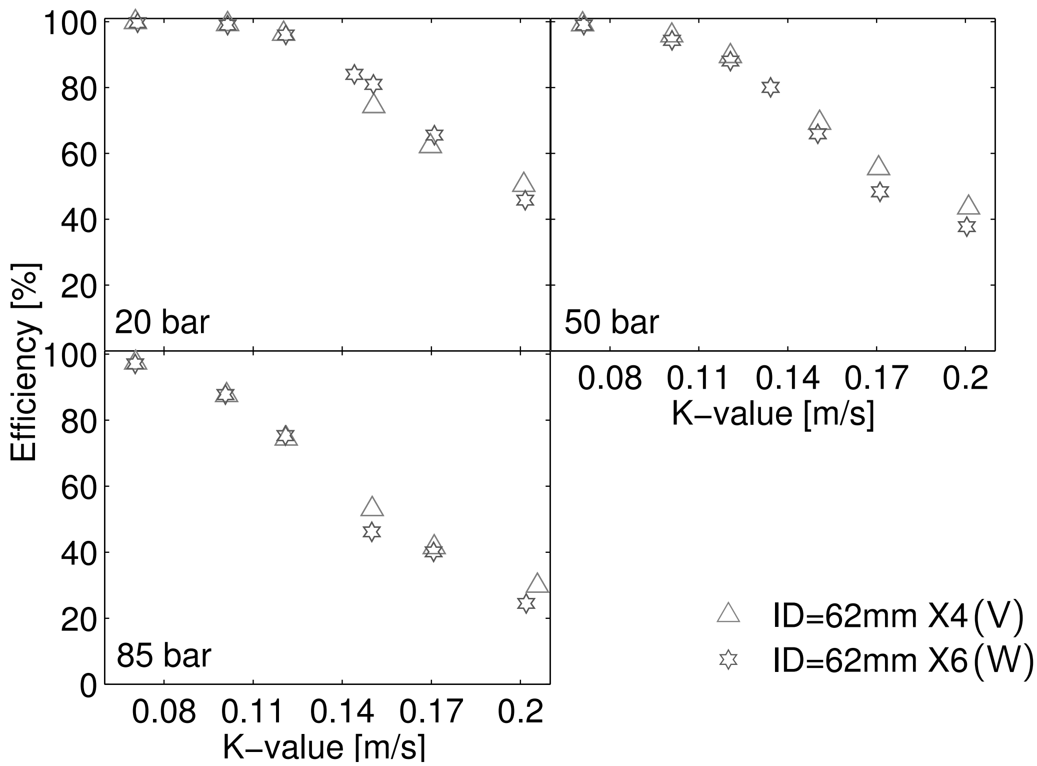

Figure 7: Separation efficiency vs. column K-value at at constant liquid fraction of 0.5 vol% at different pressures. A comparison of the to vane design with an expansion factor of 4,configuration V , and 6.7,configuration W , for the 62.7mm pipe is made.

significant. At 40 % carryover(,60 % efficiency,) the measurement error is 2.4 % in absolute percentage points and this increases as the the efficiency decreases. In effect the difference between the two setups is lower than the measurement error. There may be an effect of expansion factor and characteristic radius but it is small or non-existent.

4.2. The effect of Column geometry

Figure 8 shows the results when comparing the 252mm column with an inlet pipe diameter of 81mm and results in a 150mm column with an inlet pipe diameter of 49.2 mm. When the K-value in the two columns are the same the inlet momentum of the two inlet pipes are similar. In addition the vane geometry in the two columns are comparable. However, the expansion factor of the two vanes varies somewhat. We determined in the previous section that the effect of expansion factor is small if it exists. The main difference in the column setup is the distance between vane outlet and column wall, exemplified by the distance $L_{cw,v}$, the distance from middle of vane outlet to column wall. This implies that any liquid transported as film or droplet out of the vanes will have

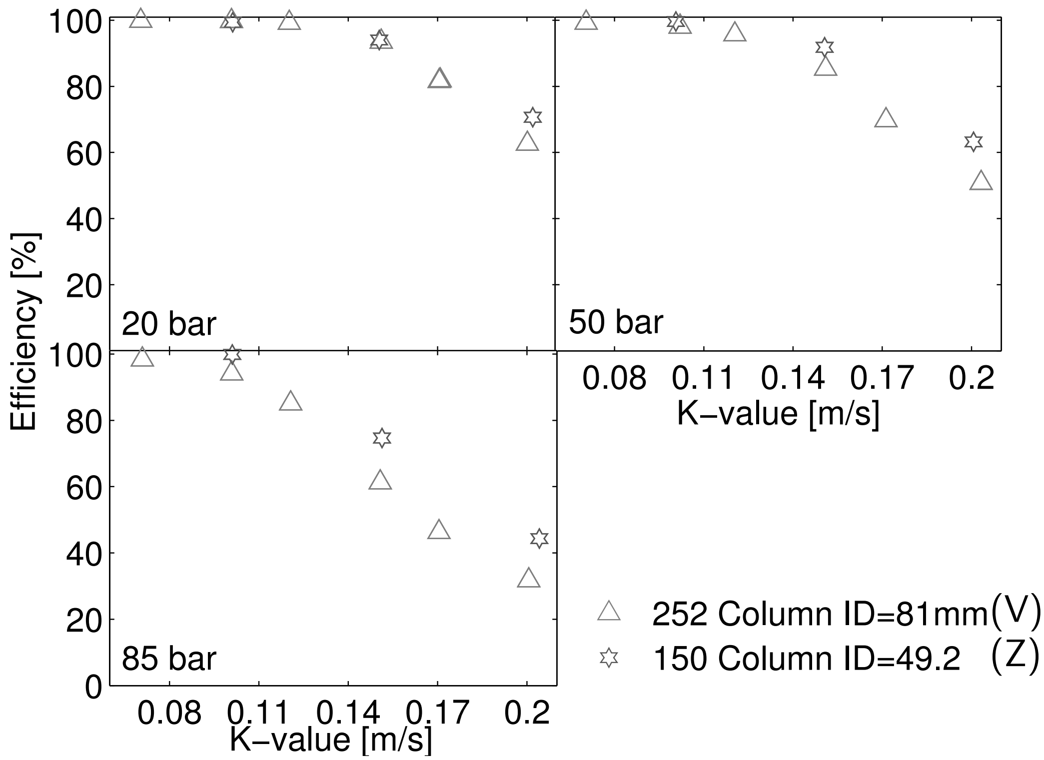

Figure 8: Separation efficiency vs. column K-value at at constant liquid fraction of 0.5 vol% at different pressures. A comparison of the inlet vane in the 252 column connected to a 81mm pipe,configuration V, and the inlet vane in the 150mm column connected with a 49.2mm pipe is made,configuration Z.

a longer travel distance to the column wall in the 252 mm column compared with the 150mm column. If we compare the separation efficiency results of the two columns at 20 bars the results for the two cases are similar. The results at 50 and 85 bars show that the separation efficiency in the 150mm column is better than in the 252mm column when compared against the column K-value. Clearly the reduced surface tension at higher pressures will affect the jets or sheets protruding from the inlet vane as the breakup time will be reduced. Any liquid sheets or jets will destabilize and form droplets as they evolve lengthwise, Marmottant and Villermaux [12], it is probable that the reduced breakup time together with jets or sheets having a longer time to evolve in the 252 mm column compared with the 150 mm column results in lower separation efficiencies for the 252mm column at 50 and 85 bars. The longer evolution time in the 252mm column will create more small droplets that are carried away with the gas and out the gas-outlet.

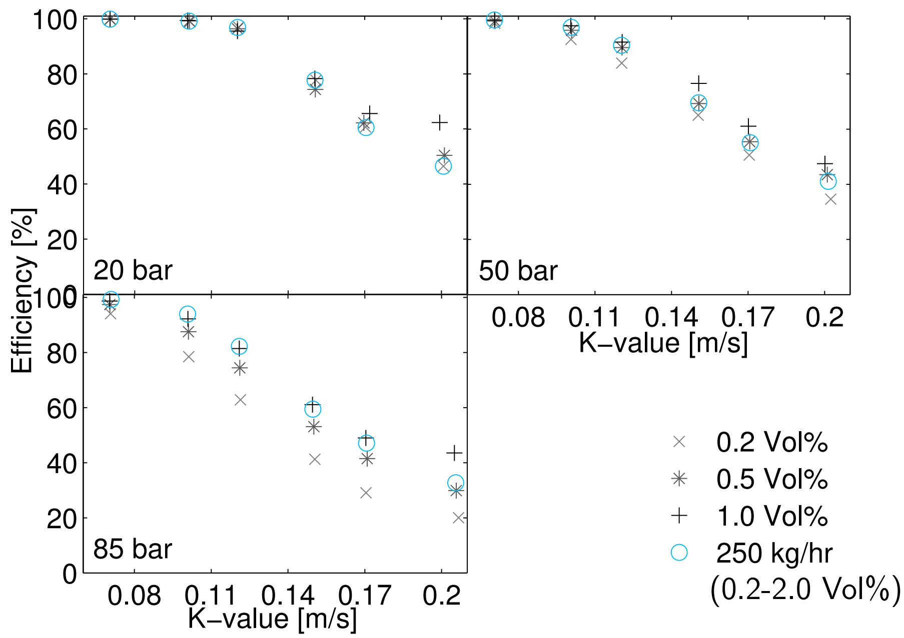

Figure 9: Separation efficiency vs. column K-value at different pressures for 62.7mm pipe, expansion factor of 4, configuration X.

4.3. The effect of increasing liquid fraction

Figure 9 shows the effect of increasing liquid fraction at a given pressure for a pipe of 62.7mm and an expansion factor of 4. A constant mass flow rate was also tested. An increase in liquid fraction leads to higher separation efficiencies at a given K-value. At 20 bars this effect is low, but is more clearly seen at 50 and 85 bars. The same influence of liquid fraction can be seen for the other inlet pipes and inlet vanes tested as seen from Figure 13, section 7.1. The case of constant mass flow rate also follows this trend when viewed as volume fraction, see Tables 3 to 7 in section 7.3. The increase in liquid fraction skews the balance between liquid re-entrainment from the liquid film, droplet coalescence and droplet depositing on the liquid film. The increased liquid fraction probably results in more droplet coalescence events as the collision frequency of droplets should increase, see section 1.1. These bigger droplets are either transported with the gas or are deposited on the liquid film which increase the liquid film rate. A higher liquid film rate should create more stable liquid sheets or jets as the thickness of the sheets and jets should increase and thus there may be less pinch off of small droplets. However, if bigger droplets are carried with the gas in the inlet pipe these will be easier to separate in the gravitational zone of the vessel. We determined that the vane design and thus vane radius did not affect separation efficiencies to a large extent so the better separation efficiencies at higher liquid volume fractions are the result of gravitational settling of bigger droplets and/or more stable jets or liquid sheets which settle out.

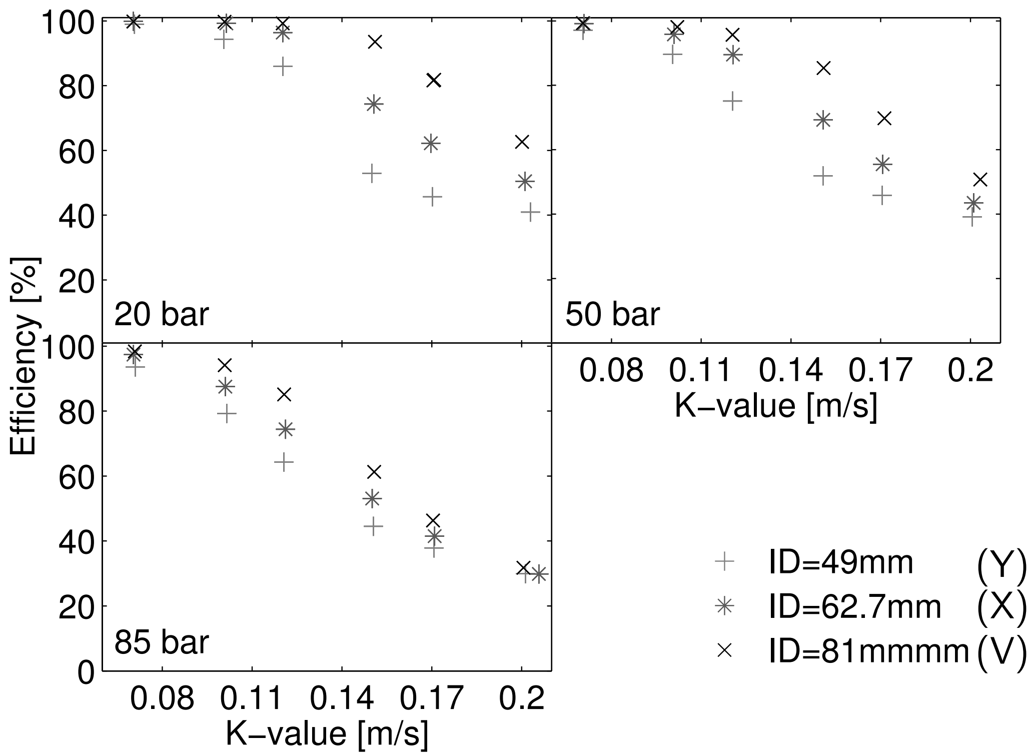

Figure 10: Separation efficiency vs. column K-value at constant liquid fraction of 0.5 vol% at different pressures. A comparison of the different inlet pipes with inlet vanes having an expansion factor of 4, configurations V, X and Z.

Figure 10 shows the effect of decreasing pipe diameters at a given pressure for three pipes, 49mm, 62.7mm and 81 mm, at a liquid rate of 0.5 vol% and an expansion factor of 4. The tendencies discussed are also valid for 0.2 vol%, 1.0 vol% and 250 kg/hr, see Figure 14. A clear effect of decreasing pipe diameter is a lowering of separation efficiency at a given K-value. For a given K-value in the column vessel the velocity is larger for a smaller pipe than in a bigger pipe, as illustrated with velocity ratio in Table 2. For the smaller pipes, this could result in more entrainment as the Weber number is increased or it could reduce the maximum droplet size in the pipe as the energy dissipation rate will increase with increasing velocity and turbulent intensity, as discussed in Section 4.5. However, here we not only see the effect of surface tension but an effect of increasing velocity when comparing the different inlet pipes.

It seems that the flow in the inlet pipes are more important than inertial impaction of droplets upon the vanes as the characteristic radius is smaller for the inlet vanes with a smaller pipe diameter, see Table 2. In effect the Stokes number should be higher with a smaller characteristic radius and it should be easier to separate the bigger droplets in the inlet pipe. If breakup and/or entrainment are dominating we may expect a droplet size distribution skewed towards smaller droplets when decreasing inlet pipe size. One would also expect that gravitational settling of droplets would be less efficient in the vessel gravitational zone and thus decreased separation efficiency at a given K-value and reduced pipe diameter. These trends are seen in Figure 10.

4.5. The effect of increasing Pressure

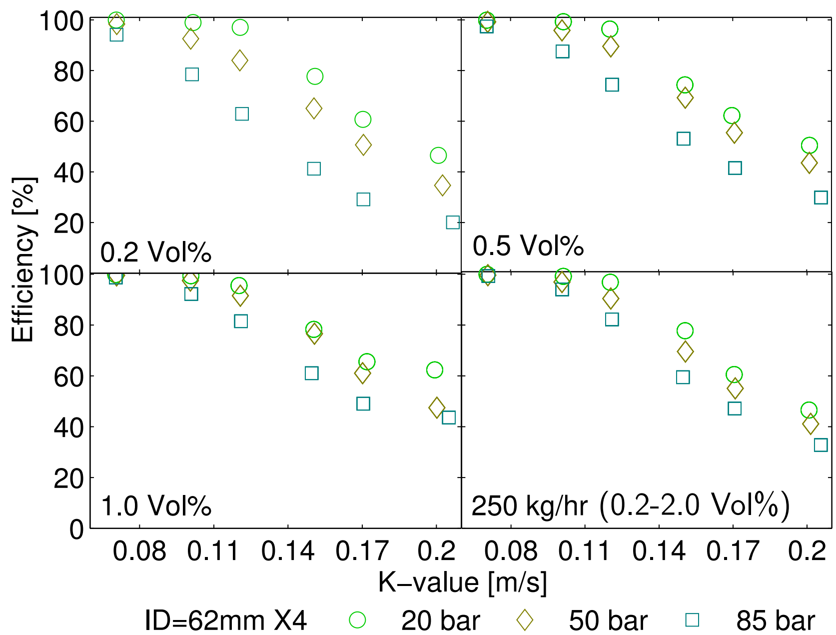

Figure 11: Separation efficiency vs. column K-value at different liquid fractions and constant mass liquid load for 62.7mm pipe, expansion factor of 4, configuration X.

Figure 11 shows the effect of increasing pressure at a given liquid fraction for a pipe of 62.7mm and an expansion factor of 4. Increasing pressure results in a lowering of surface tension and liquid density in the NG system as more gas is dissolved in the liquid phase. The effect of increasing pressure at a given volume fraction or constant mass flow rate reduces separation efficiency. This may be a result of three mechanisms, liquid deposited on the inlet pipe wall may be re-entrained or droplets in the gas stream and may breakup into smaller droplets. It may also be the result of the destabilization of liquid jets or sheets when liquid protrudes from the inlet vane. Re-entrainment as well as jet and sheet breakup is governed by the Weber number, which is the ratio of inertial forces vs. surface tension. The break-up of droplets results in a maximum droplet size in the inlet pipe dependent on surface tension and the energy dissipation rate in the gas flow, as discussed by Hinze [8]. All mechanisms are dependent on surface tension, when surface tension decreases the result is more re-entrainment, easier breakup/destabilization of sheets and jets and a smaller maximum droplet size. All mechanisms will result in more and smaller droplets in the gas flow. Smaller droplets will be harder to gravitational settle in the column vessel and thus these droplets will be carried by the gas to the column outlet and lower separation efficiencies are a result.

4.6. Inlet momentum

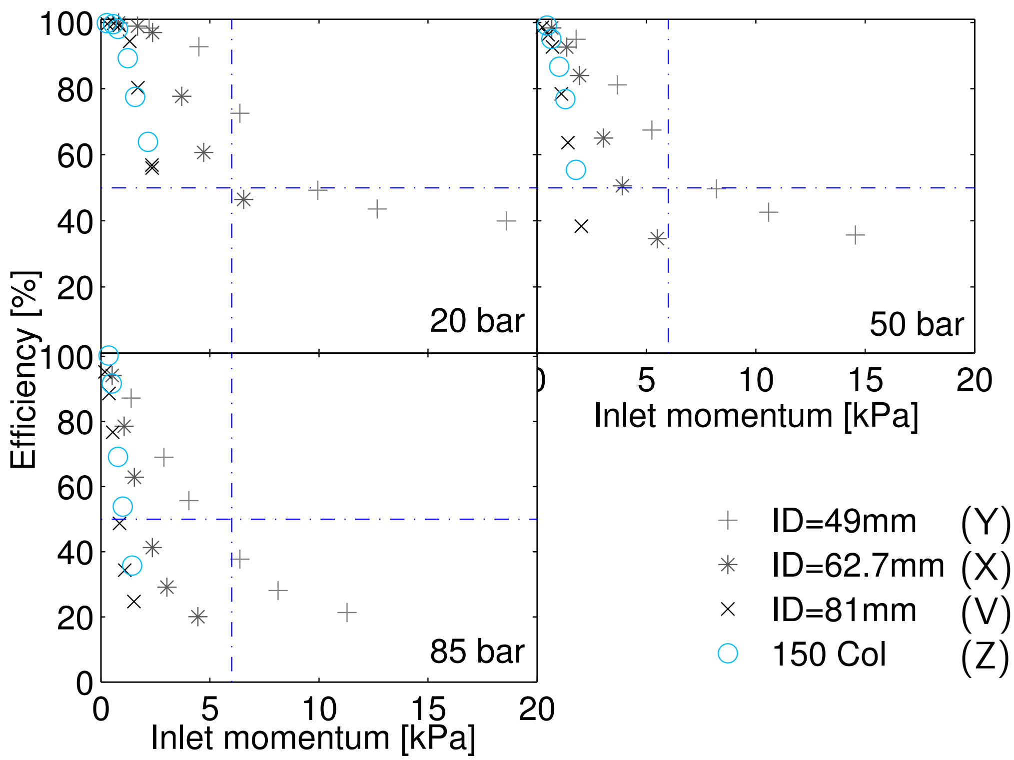

Figure 12: Separation efficiency vs. Inlet momentum at constant liquid fraction of 0.2 vol% at different pressures. For the 252 mm rig the inlet vanes compared have an expansion factor 4,configurations V, X and Y, the 150mm column inlet vane has an expansion factor of 5.4, configuration Z.

Figure 12 shows inlet momentum vs separation efficiency for the inlet vane configurations with an expansion factor of 4. In addition the results in the 150 mm column is shown. The NORSOK standard, NORSOK [13], defines a maximum inlet momentum for an inlet vane configuration to 6000 Pa. The reference inlet pipe with a diameter 62.7 mm has a maximum inlet momentum of 6000 Pa at a K-value of 0.20 m/s, see Figure 4. The 81 mm inlet pipe has a lower inlet momentum, while the 49mm pipe has a higher inlet momentum. From Figure 12 we see that the 62.7 mm pipe gives a separation efficiency just below 50 % and the 81mm is somewhat better at 6000 Pa. For 20 bars the NORSOK criterion is sufficient if we consider a separation efficiency of 50 % as sufficient criterion for inlet vane separation. However, the inlet momentum vs. separation efficiency at 50 and 85 bars for all inlet vane and pipe configurations fall below this criterion. In the preceding sections we have discussed the impact of entrainment and breakup of droplets in the inlet pipe. When surface tension is decreased and/or pipe diameter is decreased the droplet size distribution in a pipe is skewed toward smaller droplet sizes which make the separation of droplets more difficult and thus the NORSOK criterion becomes insufficient for achieving reasonable separation efficiencies.

5. Conclusion

This Article has identified several parameters relevant for separation efficiency in a scrubber inlet section:

- Increasing the expansion factor of an inlet vane does not have a large effect upon separation efficiencies.
- Increasing column diameter reduces separation efficiencies.
- Fluid properties affect separation efficiency to a large extent. When increasing pressure for a NG system at a given K-value, surface tension decreases, and a subsequent decrease in separation efficiency follows. This may be the result of several fluid mechanical processes affected by surface tension, re-entrainment of liquid droplets from a liquid film, break-up of droplets into smaller droplets, destabilization of jets or sheets creating small droplets. The creation of small droplets decreases the effect of gravitational settling in the separation vessel and thus lower separation efficiencies follows.
- Inlet pipe diameter affect separation efficiency to a large extent. When decreasing pipe diameter the velocity in the inlet pipe increases for the same scrubber column K-value. A decrease in separation efficiency is seen. This may be due to generation of a large amount of smaller droplets in the inlet pipe due to the increased velocity and these droplets are harder to separate by gravity.
- Increasing liquid volume fraction in the inlet pipe increased separation efficiency at a given K-value. The effect was small at 20 bars and increased with pressure. The higher liquid volume fractions of liquid probably create more stable jets or liquid sheets which settle out and/or skew the droplet size distribution towards bigger droplets which gravitational settle.
- The Norsok standard of keeping inlet momentum at 6000 Pa was sufficient at 20 bars, this keeps liquid separation efficiency of the inlet section at 50 % or above . However, for the systems investigated at higher pressures the Norsok criterion becomes insufficient if achieving a reasonable separation efficiency in the inlet section is desirable.

6. Acknowledgments

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7. Appendix

7.1. Effect of volume fraction liquid

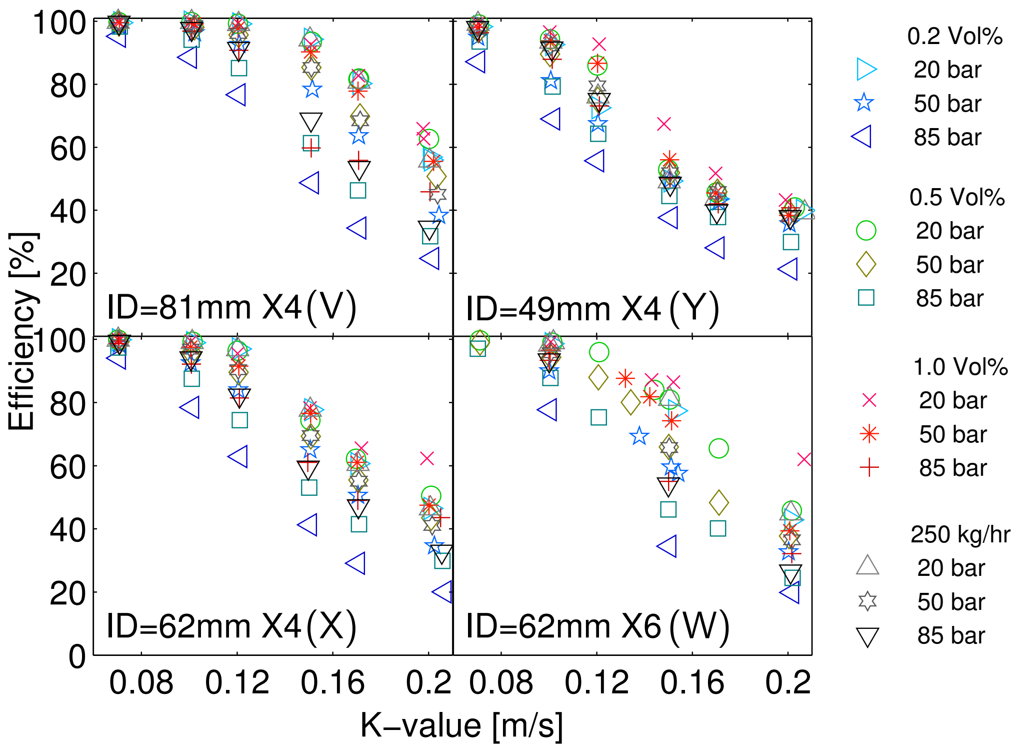


Figure 13: Efficiency vs K-value for different vane configurations, vane configurations V,W,X and Y.

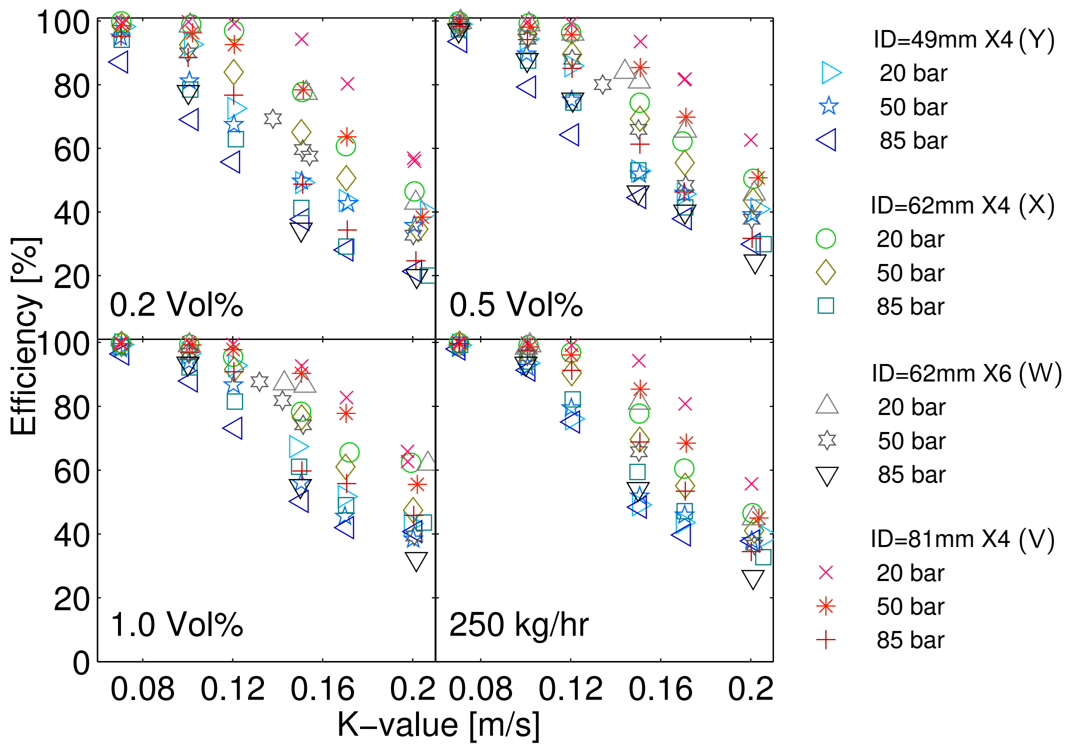


Figure 14: Efficiency vs K-value at different liquid volume fractions, vane configurations V,W,X and Y.

7.3. Results

Table 3: Efficiency measurements with standard deviation. ID=81.0mm X4.0 Expansion, 252mm column.

Pressure [bar]	ID. inlet pipe [m]	R_c- vane [m]	U_g [m/s]	K-value [m/s]	Gas rate [kg/h]	Liquid rate [kg/h]	Vol % Liq. [$Vol\%$]	Sep. Eff. [%]	Carry-over [%]	Abs Std. Dev. [%]	% Std of Carry-over [%]	Pos. above inlet vane [mm]
19.9	0.0810	1.00E-02	0.404	0.071	1307	92	0.21	99.58	0.42	0.02	5.71	408
19.9	0.0810	1.00E-02	0.571	0.100	1849	124	0.20	99.76	0.24	0.01	6.13	408
19.9	0.0810	1.00E-02	0.687	0.121	2223	151	0.20	99.17	0.83	0.05	5.69	408
19.8	0.0810	1.00E-02	0.858	0.151	2775	194	0.21	94.29	5.71	0.32	5.61	409
19.8	0.0810	1.00E-02	0.973	0.171	3149	212	0.20	80.26	19.74	1.11	5.60	409
19.8	0.0810	1.00E-02	1.141	0.200	3690	259	0.21	56.88	43.12	2.42	5.60	409
19.8	0.0810	1.00E-02	1.143	0.201	3698	260	0.21	55.95	44.05	2.47	5.60	409
19.9	0.0810	1.00E-02	0.400	0.070	1296	220	0.51	99.79	0.21	0.01	5.62	408
19.9	0.0810	1.00E-02	0.574	0.101	1856	311	0.50	99.76	0.24	0.01	5.61	408
19.9	0.0810	1.00E-02	0.684	0.120	2214	372	0.50	99.24	0.76	0.04	5.60	408
19.8	0.0810	1.00E-02	0.860	0.151	2781	471	0.51	93.52	6.48	0.36	5.59	409
19.8	0.0810	1.00E-02	0.971	0.171	3140	529	0.50	81.62	18.38	1.03	5.59	409
19.8	0.0810	1.00E-02	0.972	0.171	3145	528	0.50	81.82	18.18	1.02	5.59	409
19.8	0.0810	1.00E-02	1.139	0.200	3685	635	0.52	62.65	37.35	2.09	5.61	409
19.9	0.0810	1.00E-02	0.399	0.070	1292	253	0.59	99.82	0.18	0.01	5.61	408
19.9	0.0810	1.00E-02	0.574	0.101	1857	250	0.40	99.75	0.25	0.01	5.63	408
19.9	0.0810	1.00E-02	0.686	0.121	2219	254	0.34	99.14	0.86	0.05	5.63	408
19.8	0.0810	1.00E-02	0.856	0.150	2768	254	0.28	94.23	5.77	0.32	5.60	409
19.8	0.0810	1.00E-02	0.972	0.171	3145	255	0.24	80.79	19.21	1.08	5.60	409
19.8	0.0810	1.00E-02	1.140	0.200	3689	255	0.21	55.75	44.25	2.48	5.61	409
19.9	0.0810	1.00E-02	0.398	0.070	1288	447	1.04	99.85	0.15	0.01	5.60	408
19.9	0.0810	1.00E-02	0.572	0.101	1852	622	1.01	99.90	0.10	0.01	5.79	408
19.9	0.0810	1.00E-02	0.684	0.120	2214	761	1.03	99.41	0.59	0.03	5.59	408
19.8	0.0810	1.00E-02	0.858	0.151	2775	962	1.04	92.67	7.33	0.41	5.59	409
19.8	0.0810	1.00E-02	0.971	0.171	3141	1041	0.99	82.73	17.27	0.97	5.62	409
19.8	0.0810	1.00E-02	1.126	0.198	3643	1010	0.83	62.70	37.30	2.09	5.60	409
19.8	0.0810	1.00E-02	1.125	0.198	3640	1113	0.92	65.86	34.14	1.91	5.59	409
50.1	0.0810	1.00E-02	0.567	0.171	4668	113	0.20	63.63	36.37	2.05	5.65	408
50.1	0.0810	1.00E-02	0.678	0.204	5583	137	0.20	38.36	61.64	3.47	5.63	410
49.9	0.0810	1.00E-02	0.234	0.071	1927	47	0.20	98.55	1.45	0.09	5.94	408
49.9	0.0810	1.00E-02	0.339	0.102	2793	68	0.20	96.30	3.70	0.21	5.77	408
49.9	0.0810	1.00E-02	0.401	0.121	3301	82	0.21	92.62	7.38	0.42	5.71	408
49.9	0.0810	1.00E-02	0.503	0.151	4138	101	0.20	78.39	21.61	1.22	5.66	408
50.1	0.0810	1.00E-02	0.569	0.171	4680	284	0.50	69.79	30.21	1.69	5.60	409
50.2	0.0810	1.00E-02	0.675	0.203	5556	370	0.55	50.77	49.23	2.76	5.60	410
49.9	0.0810	1.00E-02	0.234	0.070	1926	117	0.51	99.30	0.70	0.04	5.65	408
49.9	0.0810	1.00E-02	0.339	0.102	2789	171	0.51	98.09	1.91	0.11	5.63	408
49.9	0.0810	1.00E-02	0.400	0.120	3293	198	0.50	95.71	4.29	0.24	5.62	408
49.9	0.0810	1.00E-02	0.501	0.151	4126	251	0.51	85.36	14.64	0.82	5.60	408
50.1	0.0810	1.00E-02	0.569	0.171	4684	252	0.45	68.44	31.56	1.81	5.73	409
50.1	0.0810	1.00E-02	0.676	0.204	5566	251	0.37	45.01	54.99	3.08	5.61	410
50.0	0.0810	1.00E-02	0.235	0.071	1932	252	1.08	99.65	0.35	0.02	5.61	413
49.9	0.0810	1.00E-02	0.338	0.102	2786	254	0.76	98.65	1.35	0.08	5.61	408
49.9	0.0810	1.00E-02	0.399	0.120	3288	244	0.62	96.11	3.89	0.22	5.65	408
49.9	0.0810	1.00E-02	0.501	0.151	4126	251	0.51	85.36	14.64	0.82	5.60	408
50.2	0.0810	1.00E-02	0.566	0.170	4657	627	1.12	77.81	22.19	1.24	5.59	409
50.2	0.0810	1.00E-02	0.671	0.202	5522	704	1.06	55.51	44.49	2.49	5.60	409
50.0	0.0810	1.00E-02	0.234	0.071	1930	234	1.01	99.64	0.36	0.02	5.62	414
50.0	0.0810	1.00E-02	0.339	0.102	2788	338	1.01	99.20	0.80	0.05	5.67	408
50.0	0.0810	1.00E-02	0.399	0.120	3286	424	1.07	97.78	2.22	0.12	5.61	408
50.0	0.0810	1.00E-02	0.500	0.151	4117	518	1.05	90.32	9.68	0.54	5.59	408
85.1	0.0810	1.00E-02	0.427	0.201	6750	71	0.19	24.67	75.33	4.34	5.76	408
84.9	0.0810	1.00E-02	0.363	0.171	5731	65	0.21	34.35	65.65	3.79	5.78	408
84.2	0.0810	1.00E-02	0.212	0.100	3358	37	0.20	88.60	11.40	0.70	6.14	408
84.0	0.0810	1.00E-02	0.149	0.070	2362	26	0.20	95.23	4.77	0.32	6.71	408
83.9	0.0810	1.00E-02	0.256	0.120	4038	46	0.21	76.68	23.32	1.39	5.97	408
83.8	0.0810	1.00E-02	0.321	0.151	5067	56	0.20	48.72	51.28	2.99	5.84	408
85.1	0.0810	1.00E-02	0.426	0.201	6723	190	0.51	31.74	68.26	3.86	5.65	408
84.9	0.0810	1.00E-02	0.362	0.170	5713	160	0.51	46.29	53.71	3.03	5.64	408
84.8	0.0810	1.00E-02	0.489	0.231	7734	216	0.51	34.98	65.02	3.77	5.79	408
84.8	0.0810	1.00E-02	0.532	0.251	8401	234	0.51	40.32	59.68	3.38	5.67	408
84.8	0.0810	1.00E-02	0.574	0.270	9066	253	0.51	45.36	54.64	3.13	5.72	408
84.8	0.0810	1.00E-02	0.638	0.301	10086	280	0.50	45.10	54.90	3.16	5.75	408
84.2	0.0810	1.00E-02	0.214	0.101	3381	93	0.50	94.16	5.84	0.34	5.74	408
83.8	0.0810	1.00E-02	0.150	0.071	2375	66	0.51	98.39	1.61	0.10	6.04	408
83.9	0.0810	1.00E-02	0.256	0.121	4045	113	0.51	85.14	14.86	0.84	5.68	408
83.8	0.0810	1.00E-02	0.320	0.151	5053	142	0.51	61.30	38.70	2.19	5.65	408
85.0	0.0810	1.00E-02	0.425	0.200	6712	252	0.68	34.47	65.53	3.72	5.67	408
84.9	0.0810	1.00E-02	0.363	0.171	5730	253	0.80	53.41	46.59	2.65	5.69	408
84.1	0.0810	1.00E-02	0.214	0.101	3380	253	1.36	97.58	2.42	0.14	5.69	408
84.1	0.0810	1.00E-02	0.150	0.070	2362	252	1.94	99.59	0.41	0.02	5.77	408
83.9	0.0810	1.00E-02	0.256	0.120	4039	252	1.13	91.26	8.74	0.49	5.62	408
83.9	0.0810	1.00E-02	0.320	0.151	5054	250	0.90	68.82	31.18	1.75	5.62	408
85.0	0.0810	1.00E-02	0.425	0.200	6720	377	1.02	45.85	54.15	3.05	5.62	408
84.9	0.0810	1.00E-02	0.362	0.171	5722	321	1.02	55.82	44.18	2.50	5.66	408
84.2	0.0810	1.00E-02	0.214	0.101	3382	192	1.03	96.90	3.10	0.18	5.66	408
83.9	0.0810	1.00E-02	0.256	0.121	4043	227	1.02	90.79	9.21	0.52	5.63	408
83.9	0.0810	1.00E-02	0.320	0.151	5055	241	0.87	59.77	40.23	3.20	7.95	408

Table 4: Efficiency measurements with standard deviation. ID=62.7, X4.1 Expansion, 252mm column.

Pressure [bar]	ID. inlet pipe [m]	R_c- vane [m]	U_g [m/s]	K-value [m/s]	Gas rate [kg/h]	Liquid rate [kg/h]	Vol % Liq. [$Vol\%$]	Sep. Eff. [%]	Carry-over [%]	Abs Std. Dev. [%]	% Std of Carry-over [%]	Pos. above inlet vane [mm]
20.1	0.0627	7.80E-03	0.403	0.071	1296	90	0.21	99.89	0.11	0.01	5.97	408
20.0	0.0627	7.80E-03	0.580	0.102	1866	131	0.21	98.92	1.08	0.06	5.65	408
20.0	0.0627	7.80E-03	0.689	0.121	2216	153	0.21	97.00	3.00	0.17	5.66	408
20.0	0.0627	7.80E-03	0.862	0.151	2772	198	0.21	77.70	22.30	1.25	5.60	408
20.0	0.0627	7.80E-03	0.972	0.170	3128	219	0.21	60.70	39.30	2.20	5.60	408
20.0	0.0627	7.80E-03	1.146	0.201	3688	252	0.20	46.51	53.49	3.03	5.67	408
20.1	0.0627	7.80E-03	0.402	0.070	1292	225	0.52	99.88	0.12	0.01	5.63	408
20.0	0.0627	7.80E-03	0.579	0.101	1862	316	0.51	99.24	0.76	0.04	5.60	408
20.0	0.0627	7.80E-03	0.686	0.120	2208	383	0.52	96.38	3.62	0.20	5.59	408
20.0	0.0627	7.80E-03	0.860	0.151	2767	474	0.51	74.35	25.65	1.43	5.59	408
20.0	0.0627	7.80E-03	0.969	0.170	3116	539	0.52	62.19	37.81	2.12	5.62	408
20.0	0.0627	7.80E-03	1.148	0.201	3694	633	0.51	50.44	49.56	2.77	5.60	408
20.1	0.0627	7.80E-03	0.401	0.070	1291	251	0.58	99.89	0.11	0.01	5.64	408
20.0	0.0627	7.80E-03	0.578	0.101	1859	250	0.40	99.13	0.87	0.05	5.63	408
20.0	0.0627	7.80E-03	0.686	0.120	2208	252	0.34	96.85	3.15	0.18	5.60	408
20.0	0.0627	7.80E-03	0.859	0.151	2765	252	0.27	77.74	22.26	1.25	5.60	408
20.0	0.0627	7.80E-03	0.973	0.170	3131	252	0.24	60.52	39.48	2.21	5.60	408
20.0	0.0627	7.80E-03	1.146	0.201	3688	252	0.20	46.51	53.49	3.03	5.67	408
20.1	0.0627	7.80E-03	0.402	0.070	1292	442	1.02	99.86	0.14	0.01	5.60	408
20.0	0.0627	7.80E-03	0.575	0.101	1850	630	1.01	99.40	0.60	0.03	5.59	408
20.0	0.0627	7.80E-03	0.686	0.120	2208	796	1.07	95.50	4.50	0.25	5.59	408
20.0	0.0627	7.80E-03	0.859	0.150	2763	949	1.02	78.27	21.73	1.21	5.59	408
20.1	0.0627	7.80E-03	1.138	0.199	3661	1281	1.04	62.33	37.67	2.11	5.59	408
20.0	0.0627	7.80E-03	0.982	0.172	3158	1104	1.04	65.58	34.42	1.93	5.59	408
51.5	0.0627	7.80E-03	0.329	0.101	2775	66	0.20	92.55	7.45	0.43	5.76	408
51.5	0.0627	7.80E-03	0.231	0.071	1951	46	0.20	98.35	1.65	0.10	5.95	408
51.4	0.0627	7.80E-03	0.394	0.121	3323	79	0.20	83.96	16.04	0.92	5.71	408
51.5	0.0627	7.80E-03	0.492	0.151	4151	101	0.21	65.07	34.93	1.98	5.66	408
51.5	0.0627	7.80E-03	0.558	0.171	4702	112	0.20	50.61	49.39	2.79	5.65	408
51.5	0.0627	7.80E-03	0.662	0.202	5583	137	0.21	34.62	65.38	3.69	5.64	408
51.5	0.0627	7.80E-03	0.330	0.101	2781	163	0.50	95.82	4.18	0.23	5.62	408
51.5	0.0627	7.80E-03	0.232	0.071	1952	115	0.50	99.18	0.82	0.05	5.65	408
51.5	0.0627	7.80E-03	0.395	0.121	3326	198	0.51	89.55	10.45	0.59	5.61	408
51.5	0.0627	7.80E-03	0.493	0.151	4158	247	0.51	69.26	30.74	1.72	5.60	408
51.5	0.0627	7.80E-03	0.558	0.171	4706	277	0.50	55.46	44.54	2.49	5.60	408
51.5	0.0627	7.80E-03	0.658	0.201	5545	332	0.51	43.51	56.49	3.18	5.63	408
51.5	0.0627	7.80E-03	0.329	0.101	2776	252	0.78	96.91	3.09	0.17	5.60	408
51.5	0.0627	7.80E-03	0.231	0.071	1947	254	1.12	99.57	0.43	0.02	5.61	408
51.5	0.0627	7.80E-03	0.394	0.120	3321	254	0.65	90.40	9.60	0.54	5.60	408
51.4	0.0627	7.80E-03	0.493	0.151	4156	254	0.52	69.55	30.45	1.70	5.60	408
51.5	0.0627	7.80E-03	0.559	0.171	4712	252	0.46	55.08	44.92	2.52	5.60	408
51.5	0.0627	7.80E-03	0.659	0.201	5556	253	0.39	41.10	58.90	3.30	5.61	408
51.5	0.0627	7.80E-03	0.329	0.101	2772	329	1.01	97.48	2.52	0.14	5.60	408
51.5	0.0627	7.80E-03	0.231	0.071	1949	231	1.02	99.54	0.46	0.03	5.62	408
51.5	0.0627	7.80E-03	0.395	0.121	3328	402	1.03	91.56	8.44	0.47	5.59	408
51.5	0.0627	7.80E-03	0.493	0.151	4156	491	1.01	76.55	23.45	1.31	5.59	408
51.5	0.0627	7.80E-03	0.556	0.170	4692	568	1.04	61.04	38.96	2.19	5.61	408
51.5	0.0627	7.80E-03	0.655	0.200	5520	683	1.06	47.46	52.54	2.94	5.60	408
85.3	0.0627	7.80E-03	0.214	0.101	3393	39	0.21	78.48	21.52	1.30	6.06	409
85.0	0.0627	7.80E-03	0.150	0.071	2369	28	0.21	94.09	5.91	0.38	6.47	409
84.9	0.0627	7.80E-03	0.257	0.121	4070	45	0.20	62.86	37.14	2.21	5.95	409
84.9	0.0627	7.80E-03	0.319	0.150	5045	55	0.20	41.25	58.75	3.43	5.84	409
84.9	0.0627	7.80E-03	0.361	0.170	5715	65	0.21	29.11	70.89	4.10	5.78	409
84.9	0.0627	7.80E-03	0.438	0.207	6928	80	0.21	20.05	79.95	4.58	5.73	409
85.3	0.0627	7.80E-03	0.214	0.101	3388	95	0.51	87.55	12.45	0.71	5.69	409
85.0	0.0627	7.80E-03	0.149	0.070	2359	67	0.51	97.39	2.61	0.15	5.78	409
84.9	0.0627	7.80E-03	0.257	0.121	4061	112	0.50	74.41	25.59	1.45	5.67	409
84.9	0.0627	7.80E-03	0.318	0.150	5031	139	0.50	53.10	46.90	2.65	5.65	409
84.9	0.0627	7.80E-03	0.362	0.171	5731	159	0.51	41.48	58.52	3.30	5.64	409
84.8	0.0627	7.80E-03	0.436	0.206	6897	195	0.51	29.86	70.14	3.95	5.64	409
84.9	0.0627	7.80E-03	0.489	0.231	7736	218	0.51	25.63	74.37	4.25	5.71	409
84.9	0.0627	7.80E-03	0.529	0.250	8378	238	0.52	39.15	60.85	3.45	5.66	409
84.9	0.0627	7.80E-03	0.567	0.268	8973	236	0.48	44.07	55.93	3.18	5.68	409
84.9	0.0627	7.80E-03	0.642	0.303	10157	284	0.51	52.79	47.21	2.72	5.76	409
85.3	0.0627	7.80E-03	0.214	0.101	3381	187	1.01	92.18	7.82	0.44	5.63	409
85.0	0.0627	7.80E-03	0.149	0.070	2357	134	1.04	98.70	1.30	0.07	5.66	409
84.9	0.0627	7.80E-03	0.256	0.121	4055	227	1.02	81.46	18.54	1.04	5.62	409
84.9	0.0627	7.80E-03	0.317	0.150	5012	278	1.01	61.05	38.95	2.22	5.70	409
84.9	0.0627	7.80E-03	0.361	0.170	5713	322	1.03	49.00	51.00	2.88	5.64	409
84.9	0.0627	7.80E-03	0.434	0.205	6872	378	1.00	43.56	56.44	3.17	5.62	409
85.3	0.0627	7.80E-03	0.213	0.101	3378	254	1.37	93.99	6.01	0.34	5.62	409
85.3	0.0627	7.80E-03	0.150	0.071	2375	255	1.96	99.25	0.75	0.04	5.64	409
84.9	0.0627	7.80E-03	0.256	0.121	4054	252	1.13	82.20	17.80	1.00	5.62	409
84.9	0.0627	7.80E-03	0.317	0.150	5017	249	0.90	59.42	40.58	2.28	5.62	409
84.9	0.0627	7.80E-03	0.361	0.171	5720	252	0.80	47.14	52.86	3.00	5.67	409
84.9	0.0627	7.80E-03	0.435	0.206	6891	255	0.67	32.76	67.24	3.80	5.66	409

Table 5: Efficiency measurements with standard deviation. ID=49.0mm X4.1 Expansion, 252mm column.

Pressure [bar]	ID. inlet pipe [m]	R_C- vane [m]	U_g [m/s]	K-value [m/s]	Gas rate [kg/h]	Liquid rate [kg/h]	Vol % Liq. [$Vol\%$]	Sep. Eff. [%]	Carry-over [%]	Abs Std. Dev. [%]	% Std of Carry-over [%]	Pos. above inlet vane [mm]
20.2	0.0490	6.00E-03	0.410	0.071	1297	93	0.21	98.29	1.71	0.10	5.67	411
20.2	0.0490	6.00E-03	0.584	0.101	1848	129	0.20	92.66	7.34	0.41	5.63	411
20.2	0.0490	6.00E-03	0.696	0.121	2200	157	0.21	72.54	27.46	1.54	5.62	411
20.2	0.0490	6.00E-03	0.870	0.151	2749	193	0.21	49.26	50.74	2.84	5.61	411
20.2	0.0490	6.00E-03	0.981	0.170	3102	219	0.21	43.59	56.41	3.16	5.60	411
20.2	0.0490	6.00E-03	1.189	0.206	3759	262	0.20	39.95	60.05	3.37	5.61	411
20.2	0.0490	6.00E-03	0.408	0.071	1289	223	0.51	99.02	0.98	0.06	5.61	411
20.2	0.0490	6.00E-03	0.579	0.101	1831	317	0.51	94.32	5.68	0.32	5.59	411
20.2	0.0490	6.00E-03	0.693	0.120	2193	378	0.50	85.96	14.04	0.79	5.59	411
20.2	0.0490	6.00E-03	0.864	0.150	2733	469	0.50	52.91	47.09	2.64	5.61	411
20.2	0.0490	6.00E-03	0.981	0.170	3102	536	0.50	45.69	54.31	3.04	5.60	411
20.2	0.0490	6.00E-03	1.170	0.203	3698	645	0.51	40.93	59.07	3.30	5.59	411
20.2	0.0490	6.00E-03	0.405	0.070	1282	253	0.58	99.18	0.82	0.05	5.60	411
20.2	0.0490	6.00E-03	0.581	0.101	1836	251	0.40	93.51	6.49	0.36	5.60	411
20.2	0.0490	6.00E-03	0.695	0.121	2196	252	0.34	76.11	23.89	1.34	5.60	411
20.2	0.0490	6.00E-03	0.867	0.150	2740	252	0.27	49.16	50.84	2.85	5.60	411
20.2	0.0490	6.00E-03	0.979	0.170	3094	260	0.25	43.59	56.41	3.16	5.60	411
20.2	0.0490	6.00E-03	1.193	0.207	3773	248	0.19	39.29	60.71	3.40	5.61	411
20.2	0.0490	6.00E-03	0.406	0.070	1283	455	1.04	99.35	0.65	0.04	5.59	411
20.2	0.0490	6.00E-03	0.579	0.100	1830	638	1.02	96.61	3.39	0.19	5.59	411
20.2	0.0490	6.00E-03	0.697	0.121	2205	774	1.03	92.78	7.22	0.40	5.59	411
20.2	0.0490	6.00E-03	0.854	0.148	2701	956	1.03	67.40	32.60	1.82	5.60	411
20.2	0.0490	6.00E-03	0.978	0.170	3094	1098	1.04	51.73	48.27	2.70	5.59	411
20.2	0.0490	6.00E-03	1.147	0.199	3628	1201	0.97	43.28	56.72	3.17	5.59	411
49.9	0.0490	6.00E-03	0.233	0.070	1922	47	0.20	94.93	5.07	0.30	5.91	411
49.9	0.0490	6.00E-03	0.334	0.101	2756	66	0.20	81.15	18.85	1.08	5.75	409
49.9	0.0490	6.00E-03	0.400	0.121	3297	80	0.20	67.47	32.53	1.86	5.71	409
49.8	0.0490	6.00E-03	0.500	0.151	4120	101	0.20	49.71	50.29	2.85	5.66	409
49.8	0.0490	6.00E-03	0.568	0.171	4680	114	0.20	42.63	57.37	3.24	5.64	409
49.8	0.0490	6.00E-03	0.666	0.201	5488	133	0.20	35.71	64.29	3.62	5.63	409
49.9	0.0490	6.00E-03	0.234	0.071	1928	119	0.51	97.14	2.86	0.16	5.64	411
49.9	0.0490	6.00E-03	0.333	0.100	2747	168	0.51	89.58	10.42	0.58	5.62	409
49.9	0.0490	6.00E-03	0.400	0.120	3294	200	0.50	75.11	24.89	1.40	5.61	409
49.8	0.0490	6.00E-03	0.500	0.151	4121	249	0.50	51.87	48.13	2.70	5.60	409
49.8	0.0490	6.00E-03	0.566	0.171	4663	282	0.50	45.84	54.16	3.06	5.65	409
49.8	0.0490	6.00E-03	0.666	0.201	5485	332	0.50	39.15	60.85	3.42	5.62	409
49.9	0.0490	6.00E-03	0.233	0.070	1919	251	1.09	98.12	1.88	0.11	5.60	409
49.9	0.0490	6.00E-03	0.335	0.101	2757	253	0.77	92.20	7.80	0.44	5.60	409
49.9	0.0490	6.00E-03	0.399	0.120	3290	253	0.64	79.45	20.55	1.15	5.60	409
49.8	0.0490	6.00E-03	0.500	0.151	4121	249	0.50	51.87	48.13	2.70	5.60	409
49.8	0.0490	6.00E-03	0.566	0.171	4668	253	0.45	45.91	54.09	3.06	5.66	409
49.8	0.0490	6.00E-03	0.665	0.200	5482	251	0.38	37.94	62.06	3.48	5.61	409
49.9	0.0490	6.00E-03	0.233	0.070	1920	234	1.02	98.04	1.96	0.11	5.60	409
49.9	0.0490	6.00E-03	0.334	0.101	2752	332	1.00	93.82	6.18	0.35	5.60	409
49.8	0.0490	6.00E-03	0.399	0.120	3292	403	1.02	86.66	13.34	0.75	5.59	409
49.8	0.0490	6.00E-03	0.499	0.150	4115	496	1.00	56.04	43.96	2.47	5.61	409
49.8	0.0490	6.00E-03	0.564	0.170	4645	564	1.01	45.50	54.50	3.05	5.60	409
49.8	0.0490	6.00E-03	0.665	0.200	5477	660	1.00	38.36	61.64	3.45	5.59	409
84.9	0.0490	6.00E-03	0.216	0.102	3414	38	0.20	69.02	30.98	1.89	6.09	409
84.6	0.0490	6.00E-03	0.149	0.070	2360	27	0.21	87.16	12.84	0.84	6.56	409
84.4	0.0490	6.00E-03	0.255	0.120	4031	46	0.21	55.70	44.30	2.63	5.94	409
84.2	0.0490	6.00E-03	0.320	0.151	5063	58	0.21	37.69	62.31	3.63	5.83	409
84.1	0.0490	6.00E-03	0.361	0.171	5719	65	0.21	28.07	71.93	4.16	5.78	409
84.0	0.0490	6.00E-03	0.426	0.201	6739	76	0.20	21.33	78.67	4.53	5.76	409
84.9	0.0490	6.00E-03	0.215	0.102	3404	94	0.50	79.27	20.73	1.18	5.69	409
84.6	0.0490	6.00E-03	0.150	0.071	2381	66	0.50	93.58	6.42	0.37	5.79	409
84.4	0.0490	6.00E-03	0.256	0.121	4043	112	0.50	64.29	35.71	2.02	5.67	409
84.2	0.0490	6.00E-03	0.319	0.150	5044	141	0.51	44.51	55.49	3.13	5.65	409
84.1	0.0490	6.00E-03	0.362	0.171	5724	160	0.51	37.86	62.14	3.50	5.64	409
84.0	0.0490	6.00E-03	0.427	0.201	6748	188	0.51	29.90	70.10	3.98	5.68	409
83.9	0.0490	6.00E-03	0.490	0.231	7759	219	0.52	57.73	42.27	2.41	5.70	409
83.9	0.0490	6.00E-03	0.532	0.251	8419	235	0.51	39.74	60.26	3.41	5.65	409
83.9	0.0490	6.00E-03	0.576	0.272	9113	250	0.50	45.56	54.44	3.12	5.73	409
83.8	0.0490	6.00E-03	0.635	0.300	10042	279	0.51	52.24	47.76	2.70	5.65	409
84.9	0.0490	6.00E-03	0.215	0.101	3399	190	1.02	87.92	12.08	0.68	5.63	409
84.5	0.0490	6.00E-03	0.150	0.071	2378	132	1.01	96.37	3.63	0.21	5.66	409
84.4	0.0490	6.00E-03	0.257	0.121	4062	227	1.02	73.16	26.84	1.51	5.62	409
84.2	0.0490	6.00E-03	0.319	0.151	5052	284	1.02	50.19	49.81	2.81	5.64	409
84.1	0.0490	6.00E-03	0.362	0.171	5727	319	1.01	42.03	57.97	3.26	5.63	409
84.0	0.0490	6.00E-03	0.426	0.201	6743	380	1.03	40.78	59.22	3.33	5.62	409
84.8	0.0490	6.00E-03	0.215	0.101	3394	254	1.36	91.34	8.66	0.49	5.62	409
84.8	0.0490	6.00E-03	0.149	0.070	2351	252	1.96	97.94	2.06	0.12	5.62	409
84.4	0.0490	6.00E-03	0.257	0.121	4058	253	1.14	75.06	24.94	1.40	5.62	409
84.2	0.0490	6.00E-03	0.319	0.151	5054	253	0.91	48.43	51.57	2.90	5.62	409
84.1	0.0490	6.00E-03	0.361	0.170	5709	253	0.81	39.69	60.31	3.39	5.62	409
84.0	0.0490	6.00E-03	0.426	0.201	6738	250	0.68	37.83	62.17	3.51	5.65	409

Table 6: Efficiency measurements with standard deviation. ID=62.7mm, X6.7 Expansion, 252mm column

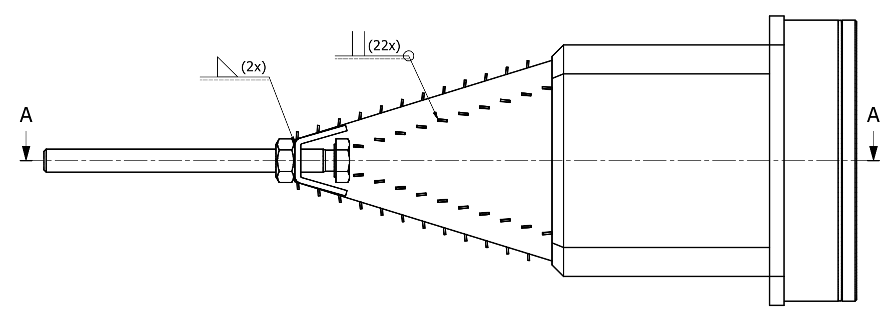
Pressure [bar]	ID. inlet pipe [m]	R_c- vane [m]	U_g [m/s]	K-value [m/s]	Gas rate [kg/h]	Liquid rate [kg/h]	Vol % Liq. [$Vol\%$]	Sep. Eff. [%]	Carry-over [%]	Abs Std. Dev. [%]	% Std of Carry-over [%]	Pos. above inlet vane [mm]
19.6	0.0627	1.00E-02	0.595	0.101	1821	326	0.51	98.94	1.06	0.06	5.59	410
19.6	0.0627	1.00E-02	0.709	0.121	2173	388	0.50	95.98	4.02	0.22	5.59	410
19.7	0.0627	1.00E-02	0.830	0.144	2628	446	0.50	84.00	16.00	0.89	5.59	411
19.6	0.0627	1.00E-02	1.003	0.171	3072	550	0.51	65.52	34.48	1.94	5.62	410
19.9	0.0627	1.00E-02	1.320	0.229	4179	699	0.49	41.74	58.26	3.26	5.60	413
19.7	0.0627	1.00E-02	1.420	0.242	4349	783	0.51	38.12	61.88	3.46	5.59	410
19.7	0.0627	1.00E-02	0.413	0.071	1286	226	0.50	99.70	0.30	0.02	5.62	411
19.7	0.0627	1.00E-02	0.877	0.151	2716	483	0.51	80.96	19.04	1.06	5.59	411
19.7	0.0627	1.00E-02	1.182	0.202	3621	648	0.51	45.77	54.23	3.05	5.63	408
19.6	0.0627	1.00E-02	0.593	0.101	1816	131	0.20	98.60	1.40	0.08	5.63	412
19.7	0.0627	1.00E-02	1.448	0.247	4434	332	0.21	33.59	66.41	3.74	5.63	410
19.7	0.0627	1.00E-02	0.886	0.153	2775	195	0.20	77.40	22.60	1.27	5.60	411
19.6	0.0627	1.00E-02	1.181	0.201	3617	261	0.20	42.88	57.12	3.20	5.61	409
19.6	0.0627	1.00E-02	0.591	0.101	1810	648	1.01	99.17	0.83	0.05	5.59	412
19.6	0.0627	1.00E-02	0.892	0.152	2731	946	0.98	86.44	13.56	0.76	5.59	410
19.8	0.0627	1.00E-02	1.212	0.207	3714	1327	1.01	62.02	37.98	2.12	5.59	412
20.0	0.0627	1.00E-02	0.823	0.143	2606	925	1.04	87.19	12.81	0.72	5.60	411
19.8	0.0627	1.00E-02	0.577	0.100	1828	252	0.40	98.33	1.67	0.09	5.60	412
19.6	0.0627	1.00E-02	0.598	0.102	1830	244	0.38	99.07	0.93	0.05	5.60	451
19.6	0.0627	1.00E-02	0.882	0.150	2702	247	0.26	81.13	18.87	1.06	5.60	457
19.5	0.0627	1.00E-02	1.180	0.201	3613	250	0.20	44.89	55.11	3.12	5.66	411
19.9	0.0627	1.00E-02	1.380	0.240	4368	245	0.16	30.30	69.70	4.02	5.76	411
19.6	0.0627	1.00E-02	1.443	0.246	4420	249	0.16	39.67	60.33	3.41	5.66	411
51.2	0.0627	1.00E-02	0.232	0.071	1967	117	0.51	98.97	1.03	0.06	5.65	411
51.1	0.0627	1.00E-02	0.329	0.101	2790	163	0.50	94.32	5.68	0.32	5.62	412
51.2	0.0627	1.00E-02	0.393	0.121	3336	195	0.50	88.00	12.00	0.67	5.61	411
50.2	0.0627	1.00E-02	0.445	0.134	3670	226	0.51	80.07	19.93	1.12	5.60	412
51.0	0.0627	1.00E-02	0.653	0.200	5541	333	0.52	37.71	62.29	3.50	5.62	412
51.1	0.0627	1.00E-02	0.882	0.271	7485	438	0.50	39.14	60.86	3.42	5.61	410
50.9	0.0627	1.00E-02	0.492	0.150	4136	245	0.50	65.94	34.06	1.91	5.60	411
51.3	0.0627	1.00E-02	0.558	0.171	4731	276	0.50	48.33	51.67	2.89	5.60	411
51.3	0.0627	1.00E-02	0.754	0.231	6397	378	0.51	30.43	69.57	3.91	5.62	411
51.1	0.0627	1.00E-02	0.816	0.250	6919	409	0.51	30.12	69.88	3.93	5.63	411
51.2	0.0627	1.00E-02	0.326	0.100	2768	67	0.21	90.00	10.00	0.58	5.80	411
50.2	0.0627	1.00E-02	0.457	0.138	3769	89	0.20	69.28	30.72	1.75	5.68	412
51.1	0.0627	1.00E-02	0.492	0.151	4177	101	0.21	59.62	40.38	2.29	5.66	410
50.2	0.0627	1.00E-02	0.511	0.154	4214	104	0.21	57.57	42.43	2.40	5.66	412
51.1	0.0627	1.00E-02	0.652	0.200	5535	134	0.21	32.71	67.29	3.79	5.63	408
51.1	0.0627	1.00E-02	0.819	0.251	6951	169	0.21	22.28	77.72	4.41	5.68	411
51.1	0.0627	1.00E-02	0.328	0.101	2780	337	1.04	96.55	3.45	0.19	5.60	410
50.2	0.0627	1.00E-02	0.438	0.132	3608	422	0.97	87.66	12.34	0.69	5.59	412
50.2	0.0627	1.00E-02	0.472	0.142	3887	467	1.00	81.83	18.17	1.02	5.59	412
51.1	0.0627	1.00E-02	0.493	0.151	4181	496	1.02	74.21	25.79	1.46	5.66	409
51.1	0.0627	1.00E-02	0.814	0.250	6906	805	1.00	47.12	52.88	2.96	5.59	410
51.1	0.0627	1.00E-02	0.654	0.201	5549	653	1.01	39.38	60.62	3.39	5.59	412
51.1	0.0627	1.00E-02	0.328	0.101	2784	252	0.78	95.80	4.20	0.24	5.60	409
51.1	0.0627	1.00E-02	0.490	0.150	4155	250	0.52	65.73	34.27	1.92	5.60	408
51.0	0.0627	1.00E-02	0.657	0.202	5575	250	0.39	36.51	63.49	3.59	5.65	410
51.1	0.0627	1.00E-02	0.814	0.250	6904	250	0.31	27.01	72.99	4.12	5.64	410
85.4	0.0627	1.00E-02	0.212	0.100	3366	37	0.20	77.69	22.31	1.36	6.11	410
84.6	0.0627	1.00E-02	0.319	0.150	5041	57	0.20	34.49	65.51	3.82	5.83	409
84.6	0.0627	1.00E-02	0.427	0.202	6764	75	0.20	19.88	80.12	4.60	5.74	410
84.5	0.0627	1.00E-02	0.530	0.250	8391	96	0.21	16.27	83.73	4.76	5.69	410
85.3	0.0627	1.00E-02	0.148	0.070	2357	66	0.52	97.05	2.95	0.17	5.77	412
85.4	0.0627	1.00E-02	0.213	0.101	3377	95	0.51	87.76	12.24	0.70	5.70	411
84.6	0.0627	1.00E-02	0.318	0.150	5027	139	0.50	46.17	53.83	3.04	5.65	408
85.2	0.0627	1.00E-02	0.361	0.171	5729	158	0.50	40.12	59.88	3.45	5.76	412
84.5	0.0627	1.00E-02	0.531	0.251	8405	233	0.51	34.15	65.85	3.71	5.63	409
85.2	0.0627	1.00E-02	0.574	0.272	9113	252	0.51	60.03	39.97	2.29	5.72	412
85.3	0.0627	1.00E-02	0.255	0.121	4055	112	0.51	75.31	24.69	1.40	5.67	412
84.6	0.0627	1.00E-02	0.428	0.202	6769	186	0.50	24.46	75.54	4.26	5.64	410
85.2	0.0627	1.00E-02	0.488	0.231	7747	217	0.51	33.94	66.06	3.74	5.67	412
85.2	0.0627	1.00E-02	0.648	0.306	10282	286	0.51	65.54	34.46	1.98	5.73	412
85.4	0.0627	1.00E-02	0.211	0.100	3358	187	1.02	93.36	6.64	0.37	5.63	409
84.6	0.0627	1.00E-02	0.530	0.250	8390	492	1.07	47.65	52.35	2.94	5.62	409
84.7	0.0627	1.00E-02	0.318	0.150	5030	281	1.02	55.06	44.94	2.52	5.62	410
84.6	0.0627	1.00E-02	0.427	0.202	6758	389	1.05	32.18	67.82	3.83	5.64	410

Table 7: Efficiency measurements with standard deviation. ID=49.2mm, X5.4 Expansion, 150mm column

Pressure	ID. inlet pipe	R_c- vane	U_g	K-value	Gas rate	Liquid rate	Vol % Liq.	Sep. Eff.	Carry-over	Abs Std. Dev.	% Std of Carry-over	Pos. above inlet vane
$[bar]$	$[m]$	$[m]$	$[m/s]$	$[m/s]$	$[kg/h]$	$[kg/h]$	$[Vol\%]$	[%]	[%]	[%]	[%]	$[mm]$
19.6	0.0492	9.00E-03	0.409	0.071	458	31	0.20	99.83	0.17	0.01	6.46	410
19.6	0.0492	9.00E-03	0.588	0.102	660	45	0.20	99.50	0.50	0.03	5.95	410
19.6	0.0492	9.00E-03	0.696	0.121	780	54	0.20	98.09	1.91	0.11	5.83	410
19.6	0.0492	9.00E-03	0.872	0.151	978	67	0.20	89.22	10.78	0.62	5.74	410
19.6	0.0492	9.00E-03	0.985	0.171	1104	75	0.20	77.51	22.49	1.29	5.71	410
19.7	0.0492	9.00E-03	1.152	0.200	1292	94	0.21	63.89	36.11	2.05	5.67	410
19.7	0.0492	9.00E-03	1.321	0.229	1482	103	0.20	54.00	46.00	2.60	5.65	410
19.7	0.0492	9.00E-03	1.432	0.249	1607	112	0.20	48.29	51.71	2.92	5.64	410
19.6	0.0492	9.00E-03	0.583	0.101	654	113	0.50	99.38	0.62	0.04	5.65	410
19.7	0.0492	9.00E-03	0.866	0.150	972	168	0.51	94.02	5.98	0.34	5.61	410
19.7	0.0492	9.00E-03	1.163	0.202	1304	226	0.51	70.67	29.33	1.64	5.60	410
19.7	0.0492	9.00E-03	1.430	0.248	1603	279	0.51	58.90	41.10	2.30	5.59	410
19.7	0.0492	9.00E-03	0.579	0.101	649	261	1.18	99.87	0.13	0.01	5.60	410
19.7	0.0492	9.00E-03	0.866	0.150	972	259	0.78	95.92	4.08	0.23	5.60	410
19.7	0.0492	9.00E-03	1.162	0.202	1303	254	0.57	71.10	28.90	1.62	5.60	410
19.7	0.0492	9.00E-03	1.428	0.248	1602	260	0.47	58.36	41.64	2.33	5.60	410
51.4	0.0492	9.00E-03	0.329	0.101	984	23	0.20	99.09	0.91	0.06	6.77	410
51.4	0.0492	9.00E-03	0.396	0.121	1184	30	0.21	95.02	4.98	0.32	6.35	410
51.4	0.0492	9.00E-03	0.493	0.151	1473	36	0.21	86.63	13.37	0.82	6.13	410
51.4	0.0492	9.00E-03	0.560	0.171	1673	40	0.20	76.85	23.15	1.40	6.03	410
51.4	0.0492	9.00E-03	0.656	0.201	1960	47	0.20	55.44	44.56	2.63	5.91	410
51.4	0.0492	9.00E-03	0.760	0.232	2271	54	0.20	36.26	63.74	3.72	5.83	410
51.4	0.0492	9.00E-03	0.821	0.251	2452	57	0.20	36.22	63.78	3.70	5.81	410
51.4	0.0492	9.00E-03	0.329	0.101	983	59	0.51	99.65	0.35	0.02	5.83	410
51.4	0.0492	9.00E-03	0.493	0.151	1472	89	0.52	91.85	8.15	0.46	5.68	410
51.4	0.0492	9.00E-03	0.656	0.201	1961	115	0.50	63.21	36.79	2.08	5.64	410
51.4	0.0492	9.00E-03	0.820	0.251	2449	145	0.51	47.29	52.71	2.96	5.62	410
51.5	0.0492	9.00E-03	0.330	0.101	987	253	2.19	99.74	0.26	0.01	5.60	410
51.4	0.0492	9.00E-03	0.494	0.151	1477	252	1.46	95.05	4.95	0.28	5.60	410
51.4	0.0492	9.00E-03	0.656	0.201	1959	255	1.11	71.25	28.75	1.61	5.60	410
51.4	0.0492	9.00E-03	0.822	0.251	2456	254	0.89	53.35	46.65	2.61	5.60	410
84.7	0.0627	1.00E-02	0.212	0.100	3356	249	1.35	93.36	6.64	0.37	5.63	411
84.6	0.0627	1.00E-02	0.318	0.150	5029	251	0.91	54.11	45.89	2.58	5.62	410
84.6	0.0627	1.00E-02	0.426	0.201	6741	252	0.68	26.55	73.45	4.14	5.63	409
84.6	0.0627	1.00E-02	0.533	0.252	8432	248	0.54	36.48	63.52	3.61	5.68	410
84.5	0.0492	9.00E-03	0.214	0.101	1201	33	0.50	99.86	0.14	0.01	7.19	410
84.5	0.0492	9.00E-03	0.321	0.151	1797	50	0.50	74.70	25.30	1.49	5.89	410
84.4	0.0492	9.00E-03	0.432	0.204	2424	68	0.51	44.37	55.63	3.21	5.76	410
83.9	0.0492	9.00E-03	0.529	0.250	2964	81	0.50	30.42	69.58	3.98	5.72	410
84.5	0.0492	9.00E-03	0.214	0.101	1201	12	0.19	100.21	-0.21	0.03	12.16	410
84.4	0.0492	9.00E-03	0.255	0.120	1427	16	0.20	91.64	8.36	0.65	7.81	410
84.4	0.0492	9.00E-03	0.321	0.151	1798	20	0.20	69.10	30.90	2.19	7.10	410
84.4	0.0492	9.00E-03	0.362	0.171	2028	23	0.21	53.84	46.16	3.13	6.78	410
84.4	0.0492	9.00E-03	0.433	0.204	2428	27	0.21	35.71	64.29	4.16	6.47	410
84.0	0.0492	9.00E-03	0.529	0.250	2967	33	0.20	20.10	79.90	4.98	6.23	410
84.7	0.0492	9.00E-03	0.213	0.101	1197	255	3.89	99.97	0.03	0.00	7.09	410
84.6	0.0492	9.00E-03	0.320	0.151	1796	252	2.56	90.71	9.29	0.52	5.62	410
84.5	0.0492	9.00E-03	0.432	0.204	2424	240	1.80	63.58	36.42	2.05	5.62	410
84.0	0.0492	9.00E-03	0.528	0.249	2958	252	1.55	42.51	57.49	3.24	5.63	410

7.4. Inlet vane design

7.4.1. Inlet pipe ID=49mm, X4



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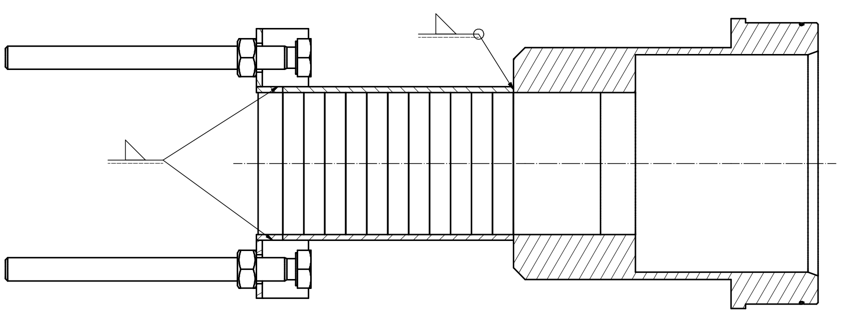
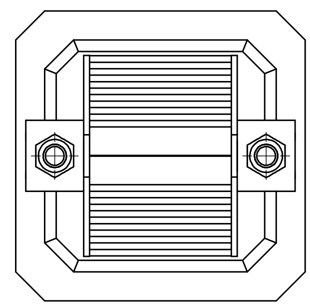
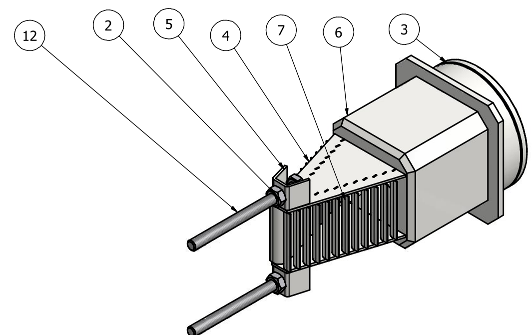






FOR INFORMATION ONLY

REVISION HISTORY

REV	STATUS	DESCRIPTION	DATE	APPROVED
A	Issued for			

PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
2	2	DIN 934 - M8	Hex Nut	Steel, Mild
3	1	O-ring 90x1	O-ring 90x1	Nitrile
4	2	R-07 400 M-P 690	Plate	Stainless Steel
5	2	R-07 400 M-P 695	Bracket	Stainless Steel
6	1	R-07 400 M-P 696	Inlet bracket	Stainless Steel
7	24	R-07 400 M-P 699	Inlet blade	Stainless Steel
12	2	DIN 933 - M8 x 100	Hex-Head Bolt	Steel, Mild

Project: HP-rigg

Date: 29.05.2013

Designed by: ANRAN

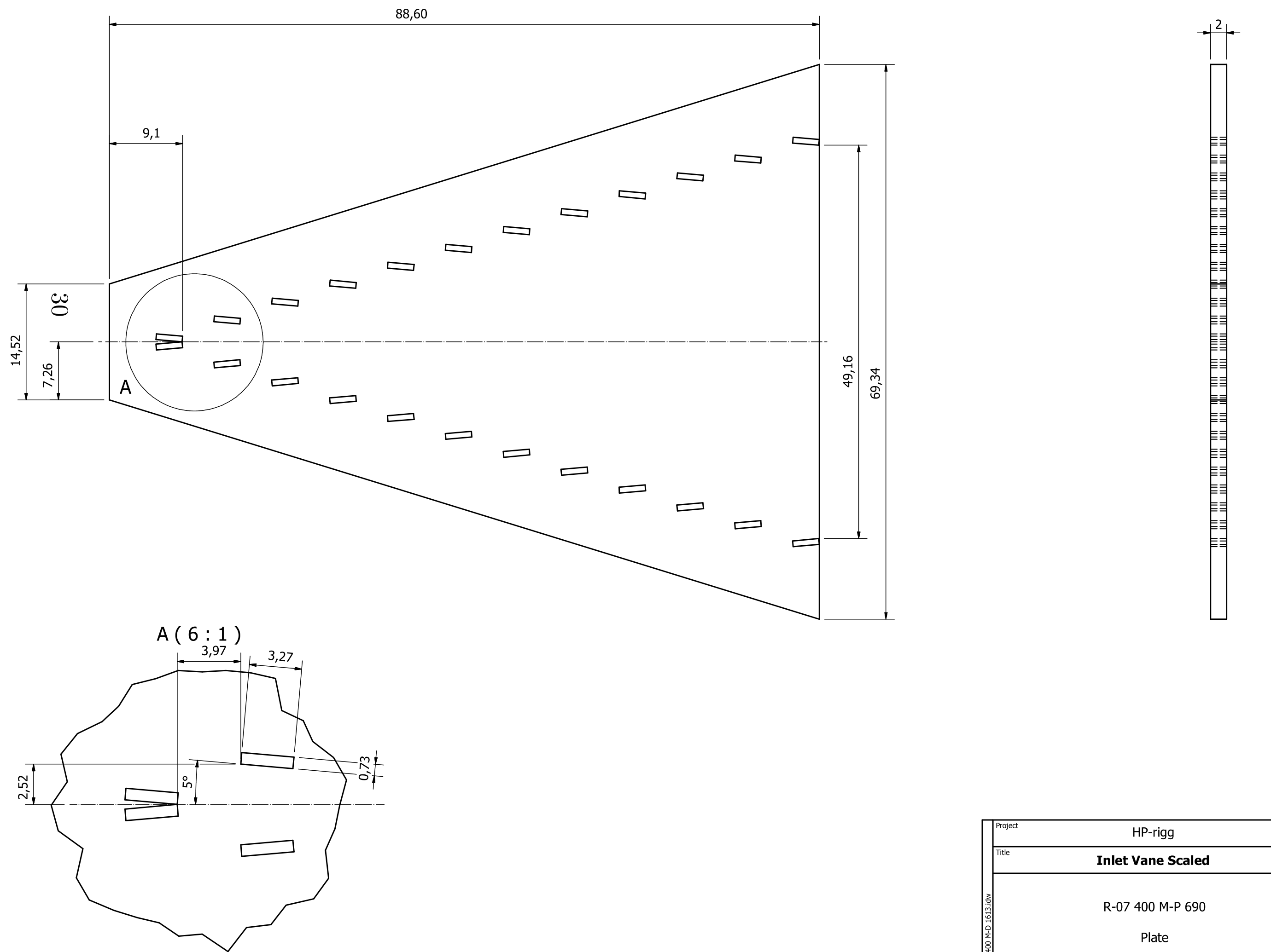
Title: **Inlet Vane Scaled**

R-07 400 M-PA 613

INLET VANE ASSEMBLY

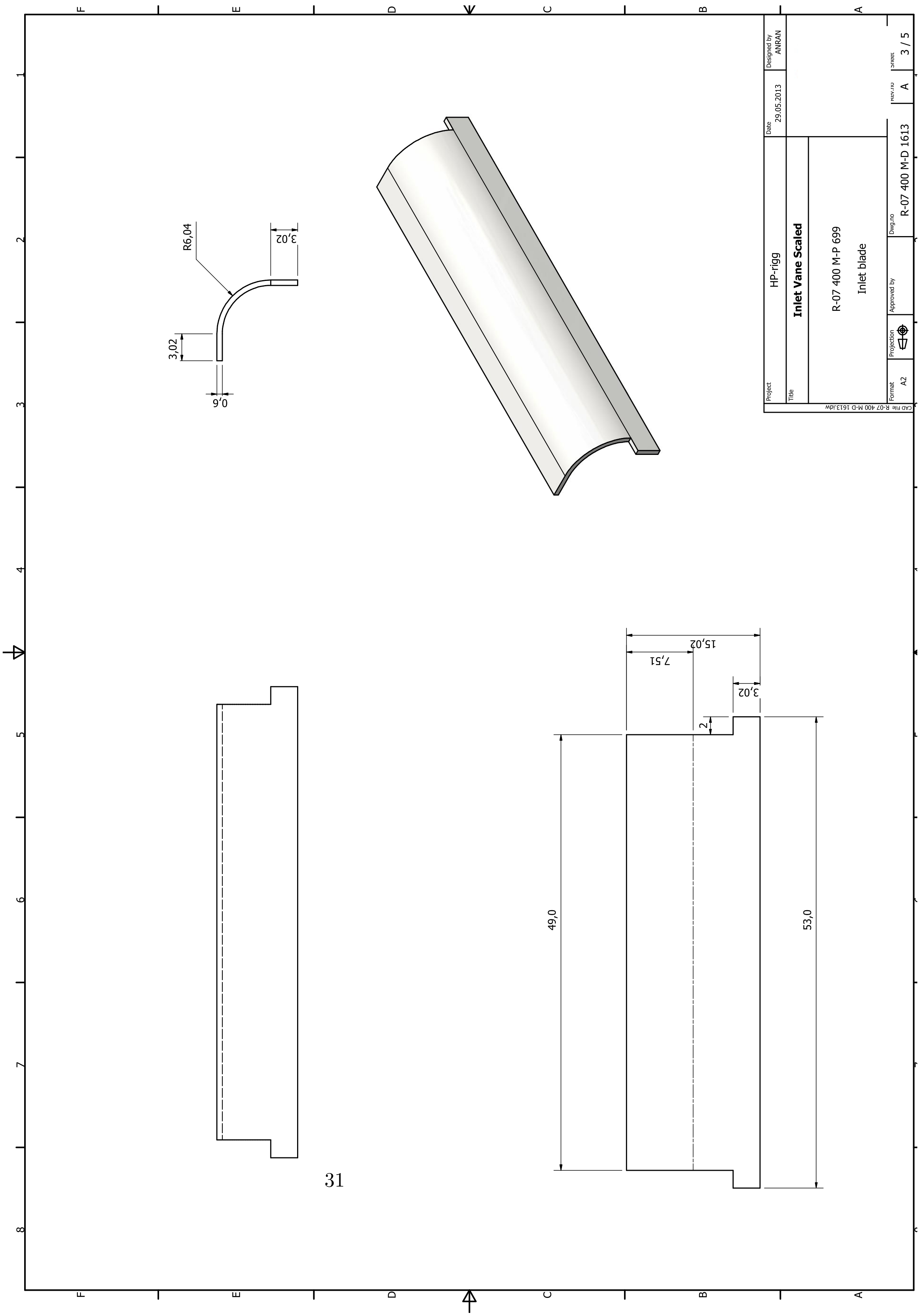
CAD File: R-07 400 M-D 1613.idw

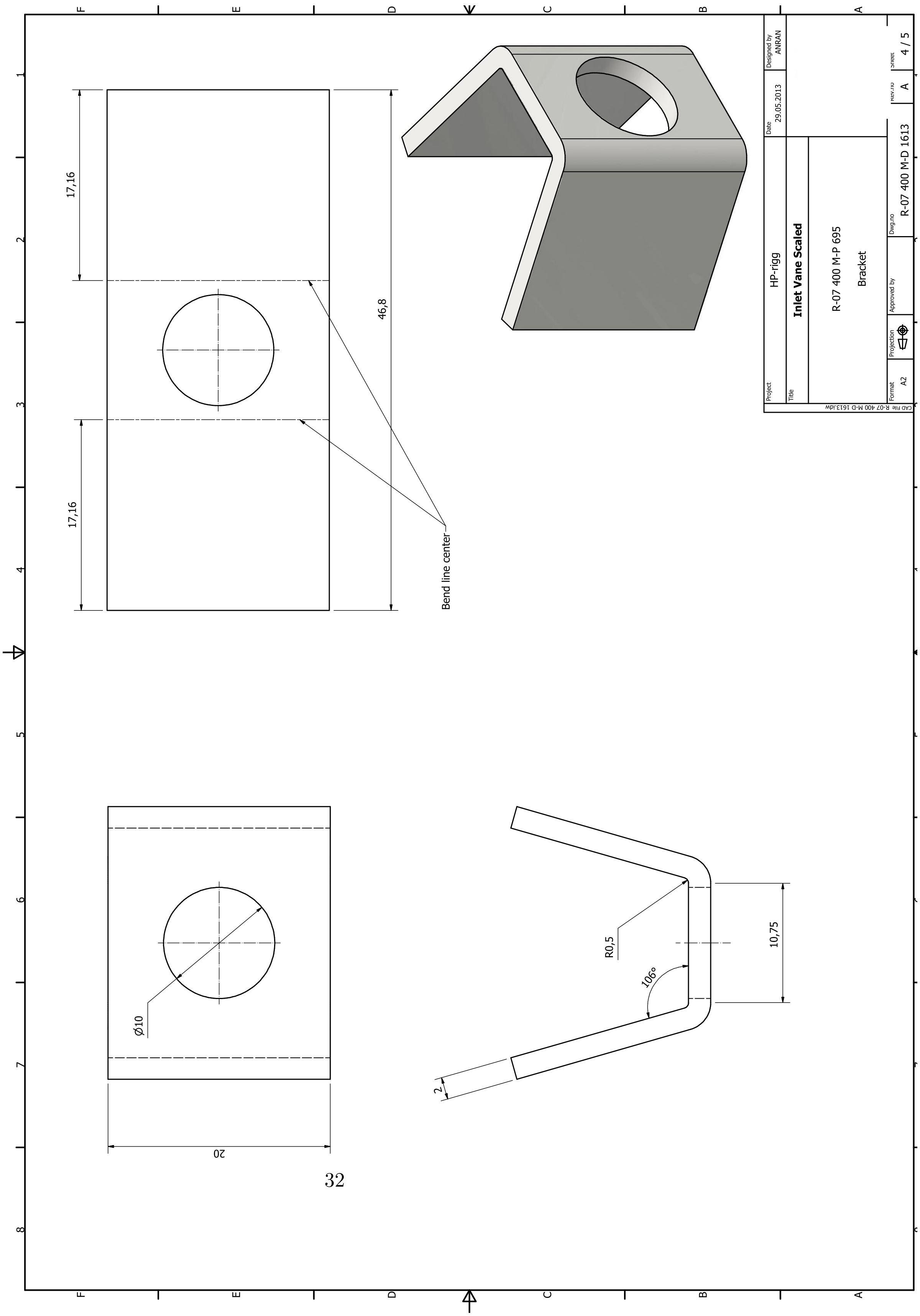
Format	Projection	Approved by	Dwg.no	Rev.no	Sheet
A2			R-07 400 M-D 1613	A	1 / 5

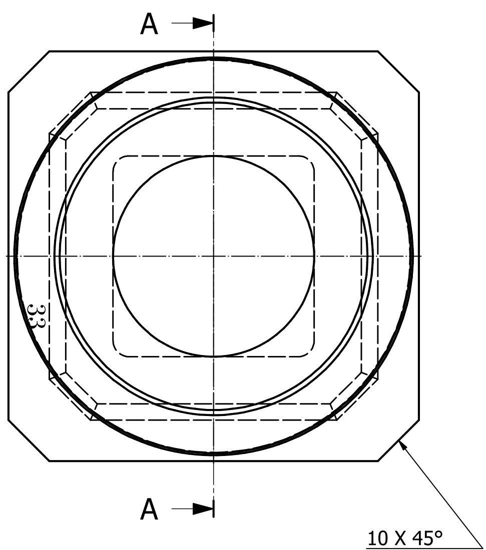


Project: HP-rigg		Date: 29.05.2013	Designed by: ANRAN
Title: **Inlet Vane Scaled**			
R-07 400 M-P 690 Plate			
Format: A2	Projection	Approved by	Dwg.no: R-07 400 M-D 1613 · Rev.no: A · Sheet: 2 / 5

CAD File: R-07 400 M-D 1613.idw


Designed by
ANRAN
Date
29.05.2013
Project
HP-rigg
Title
Inlet Vane Scaled
R-07 400 M-P 699
Inlet blade
Approved by
Projection
Format
A2
Dwg.no
R-07 400 M-D 1613
Rev.no
A
Sheet
3 / 5
CAD File R-07 400 M-D 1613.idw
R6,04
3,02
3,02
0,6
15,02
7,51
3,02
2
49,0
53,0


17,16
17,16
46,8
Bend line center
Ø10
20
R0,5
106°
10,75
2
Designed by
ANRAN
Date
29.05.2013
Project
HP-rigg
Title
Inlet Vane Scaled
R-07 400 M-P 695
Bracket
Sheet
4 / 5
Rev.no
A
Dwg.no
R-07 400 M-D 1613
Approved by
Projection
Format
A2
CAD File R-07 400 M-D 1613.idw



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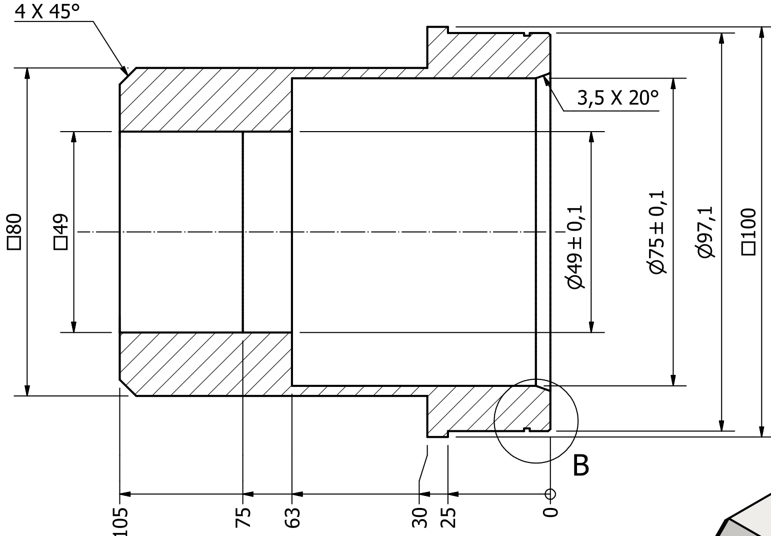

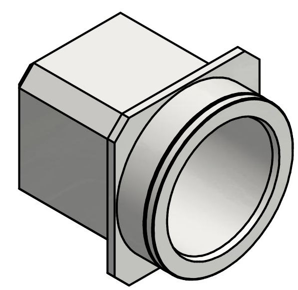

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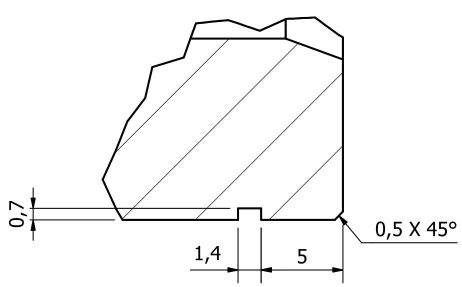
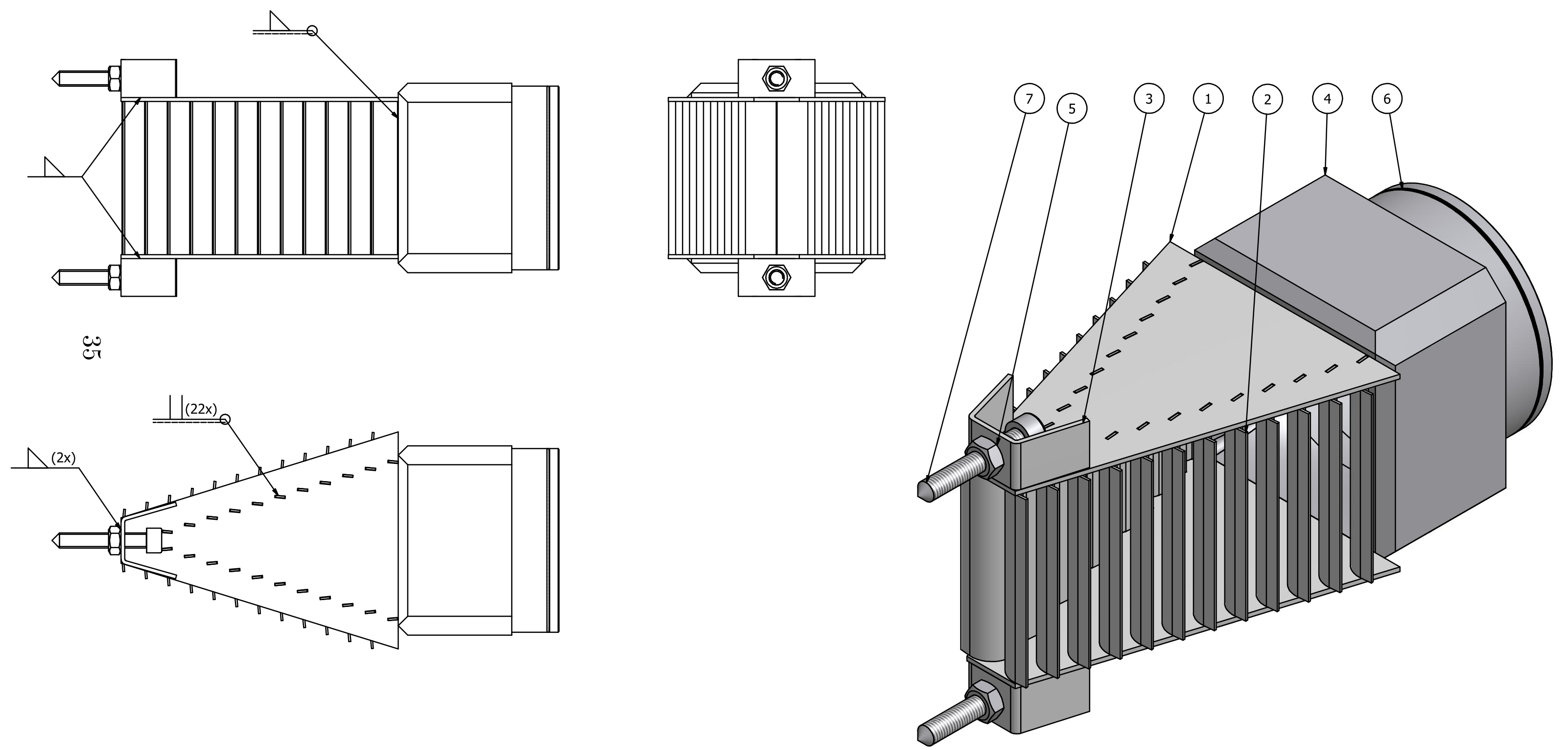


Project: HP-rigg			Date: 29.05.2013	Designed by: ANRAN
Title: **Inlet Vane Scaled**				
R-07 400 M-P 696 Inlet bracket				
Format: A3	Projection	Approved by	Dwg.no: R-07 400 M-D 1613	Rev.no: A / Sheet: 5 / 5

CAD File R-07 400 M-D 1613.idw

7.4.2. Inlet pipe ID=62.7, X6. ID=81mm, X4



PARTS LIST				
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
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2	24	R-07 400 M-P 659	Inlet blade	Stainless Steel
3	2	R-07 400 M-P 665	Bracket	Stainless Steel
4	1	R-07 400 M-P 666	Inlet bracket	Stainless Steel
5	2	DIN 934 - M8	Hex Nut	Stainless Steel
6	1	O-ring 90x1	O-ring 90x1	Nitrile
7	2	DIN 912 - M8 x 50	Cylinder Head Cap Screw	Stainless Steel

Project: HP-rigg

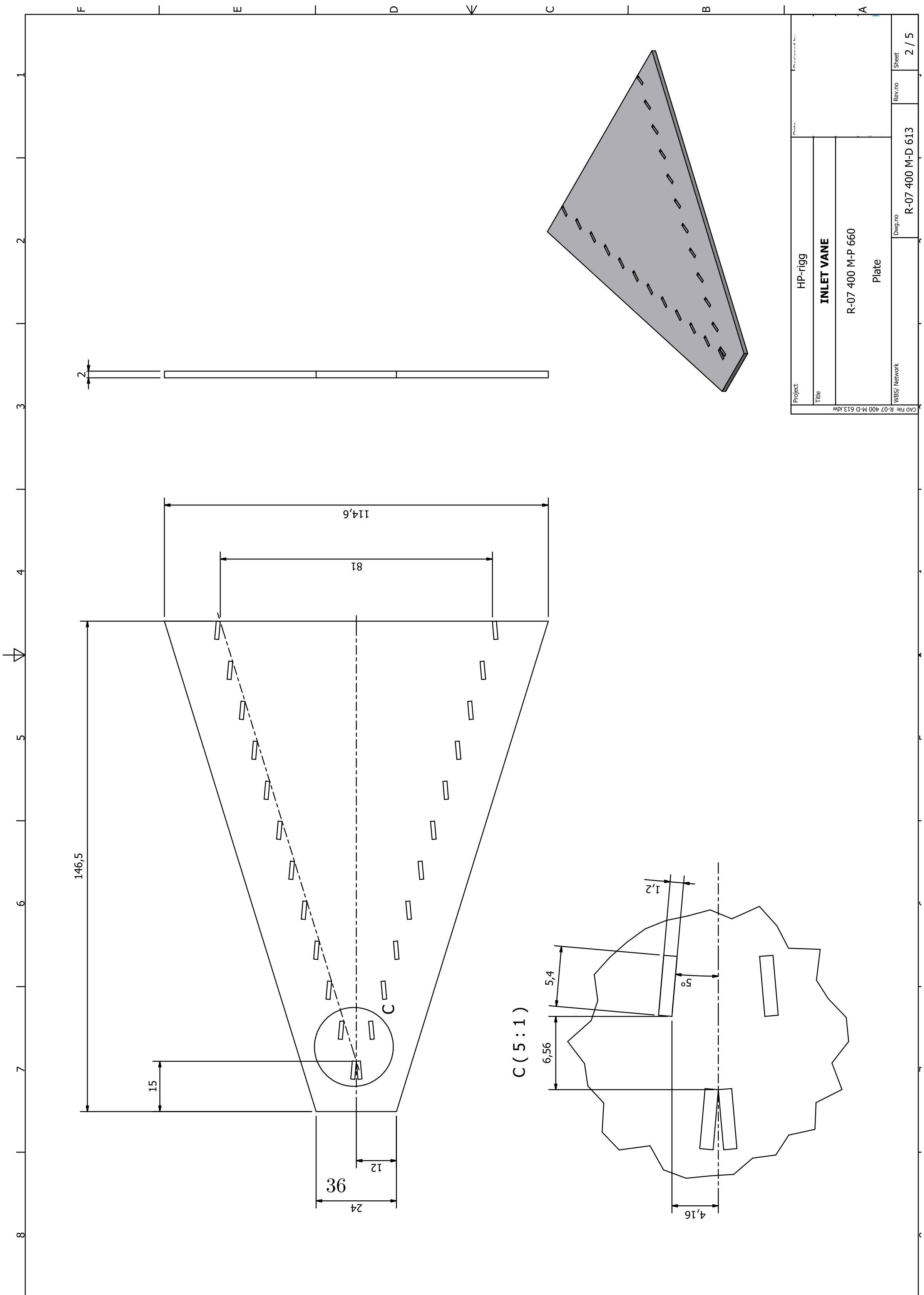
Title: **INLET VANE**

R-07 400 M-PA 603

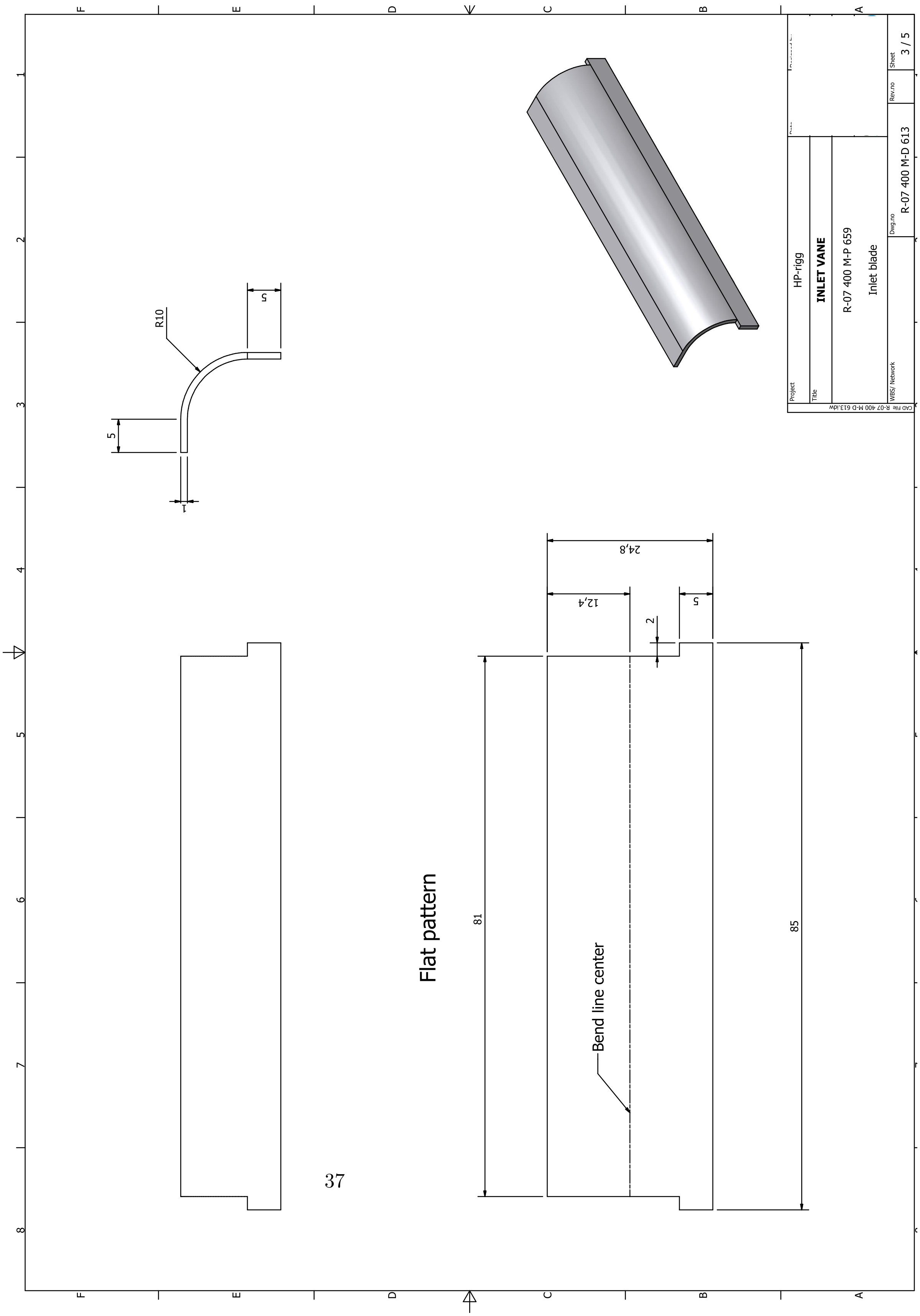
INLET VANE ASSEMBLY

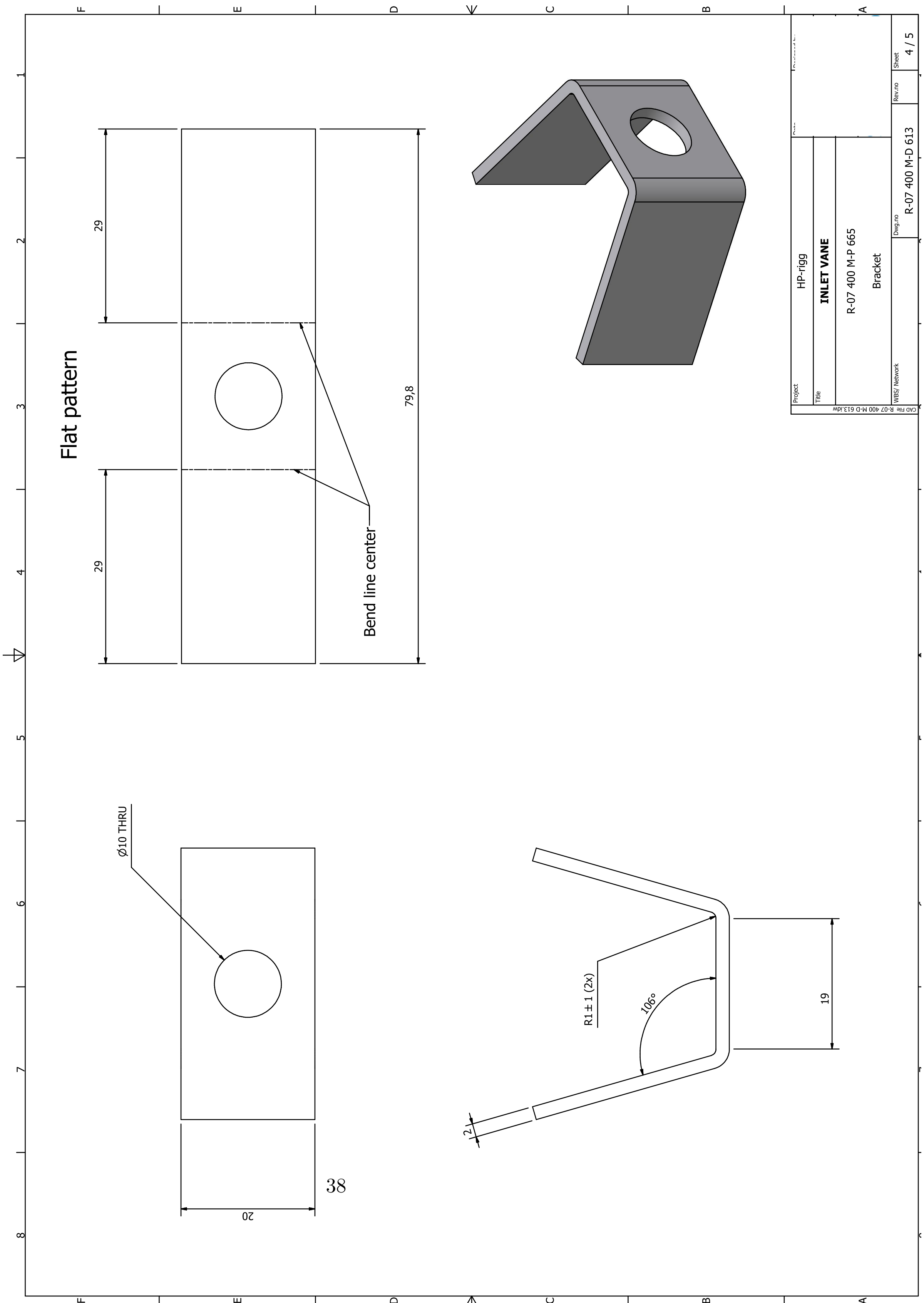
CAD File: R-07 400 M-D 613.idw

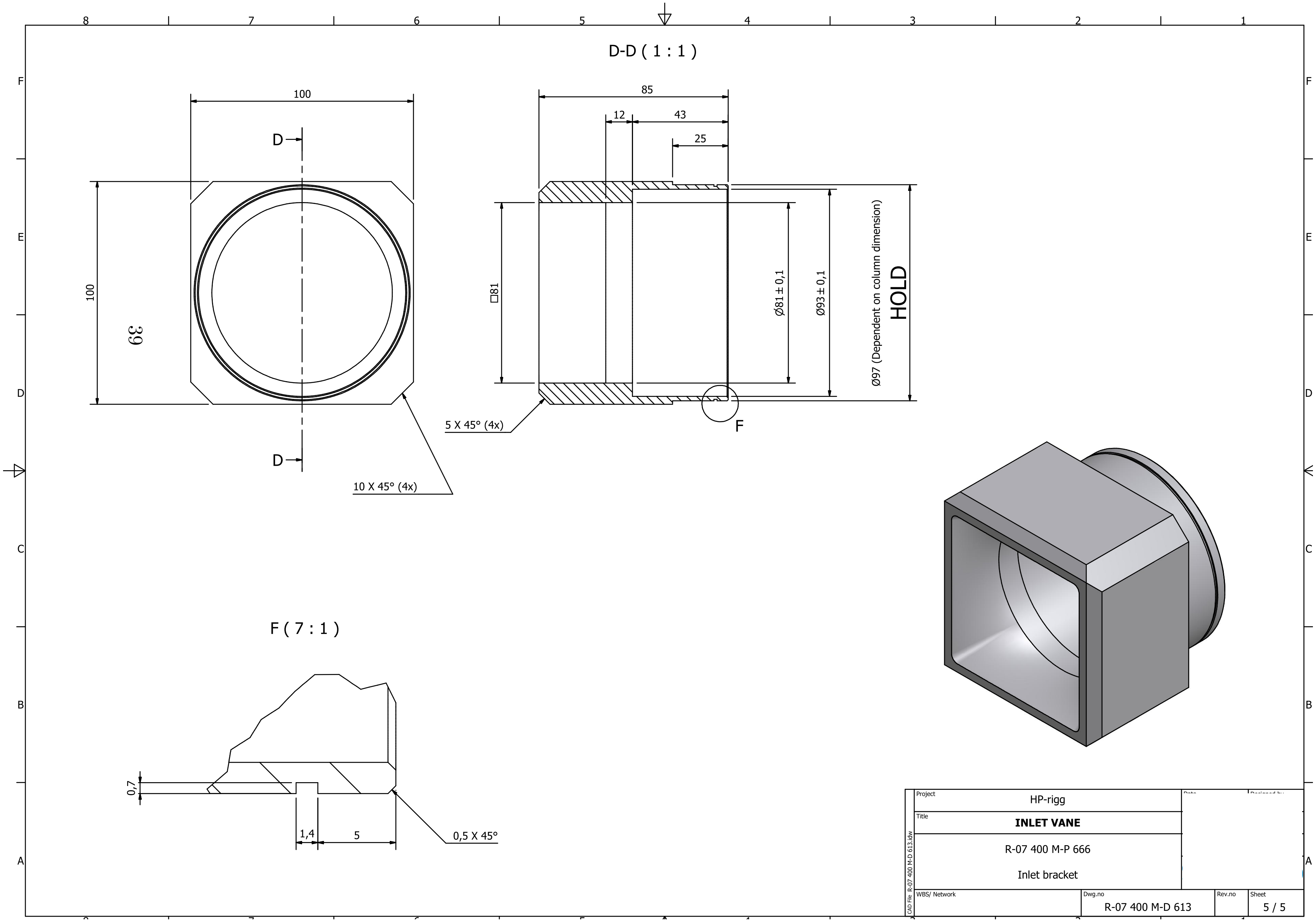
WBS/ Network	Dwg.no	Rev.no	Sheet
	R-07 400 M-D 613		1 / 5



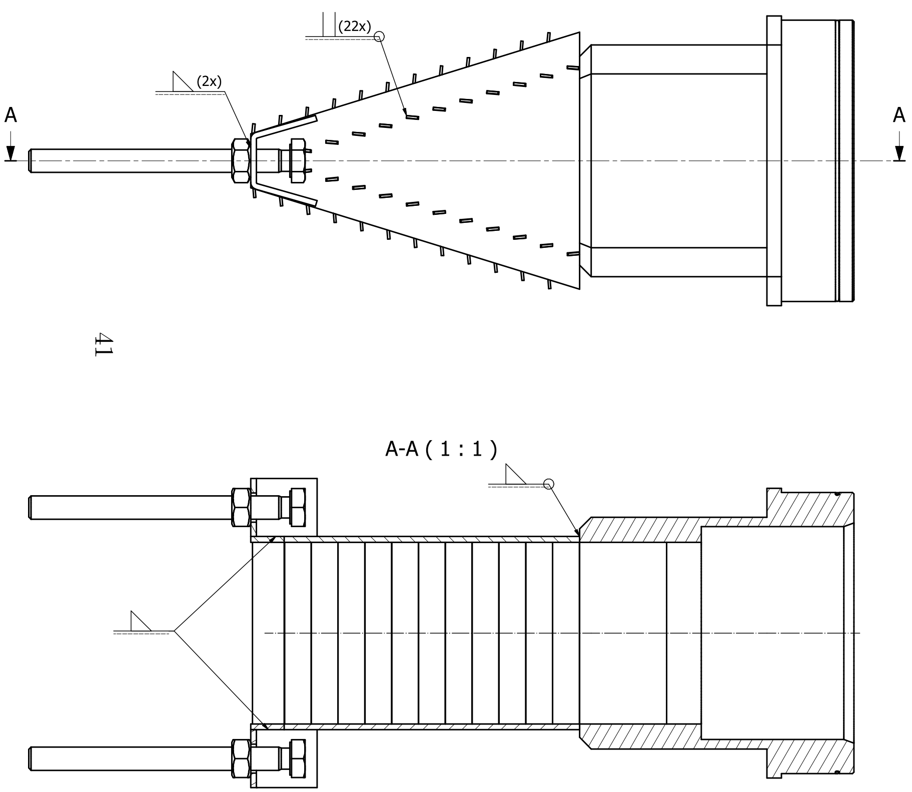
Project
HP-rigg
Title
INLET VANE
R-07 400 M-P 660
Plate
WBS/ Network
Dwg.no
R-07 400 M-D 613
Rev.no
Sheet
2 / 5
CAD File: R-07 400 M-D 613.idw
2
114,6
81
146,5
15
12
24
C
C (5 : 1)
1,2
5,4
5°
6,56
4,16


Flat pattern
Bend line center
R10
5
1
24,8
12,4
2
81
85
Project
HP-rigg
Title
INLET VANE
R-07 400 M-P 659
Inlet blade
WBS/ Network
Dwg.no
R-07 400 M-D 613
Rev.no
Sheet
3 / 5
CAD File: R-07 400 M-D 613.idw

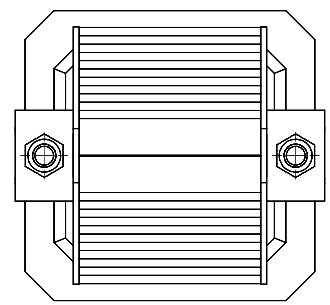

Flat pattern
29
29
79,8
Bend line center
Ø10 THRU
20
R1 ± 1 (2x)
106°
19
2
Project
HP-rigg
Title
INLET VANE
R-07 400 M-P 665
Bracket
WBS/ Network
Dwg.no
R-07 400 M-D 613
Rev.no
Sheet
4 / 5
CAD File R-07 400 M-D 613.idw

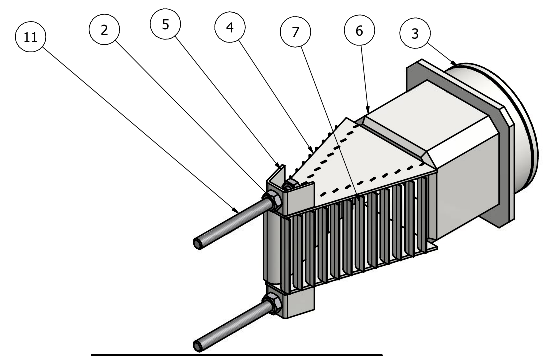

D-D (1 : 1)
100
100
D
D
10 X 45° (4x)
85
12
43
25
□81
Ø81 ± 0,1
Ø93 ± 0,1
Ø97 (Dependent on column dimension)
HOLD
5 X 45° (4x)
F
F (7 : 1)
0,7
1,4
5
0,5 X 45°
Project
HP-rigg
Title
INLET VANE
R-07 400 M-P 666
Inlet bracket
WBS/ Network
Dwg.no
R-07 400 M-D 613
Rev.no
Sheet
5 / 5
CAD File: R-07 400 M-D 613.idw

7.4.3. Inlet pipe ID=62.7, X6



REVISION HISTORY				
REV	STATUS	DESCRIPTION	DATE	APPROVED
A	Issued for			





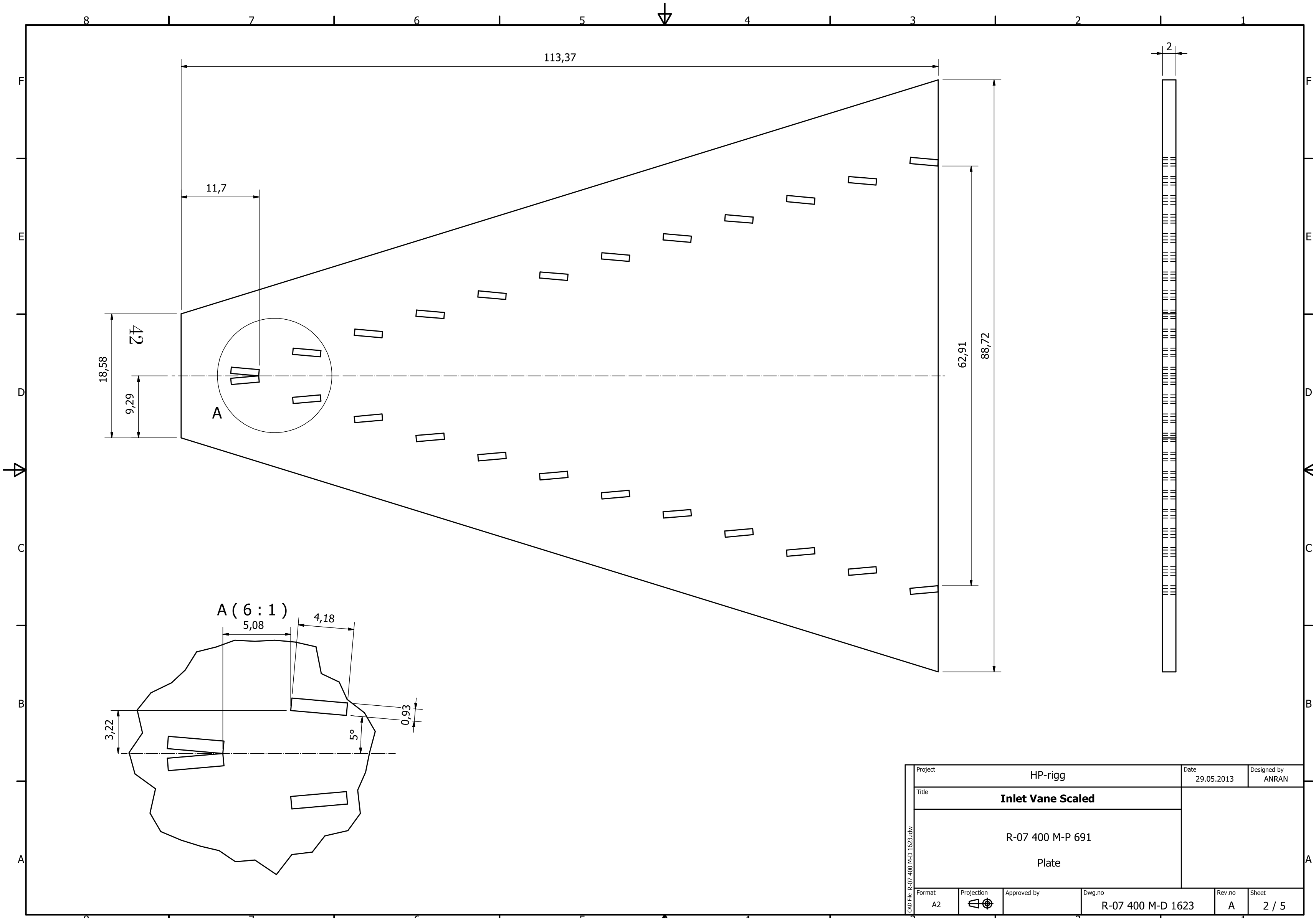
FOR INFORMATION ONLY

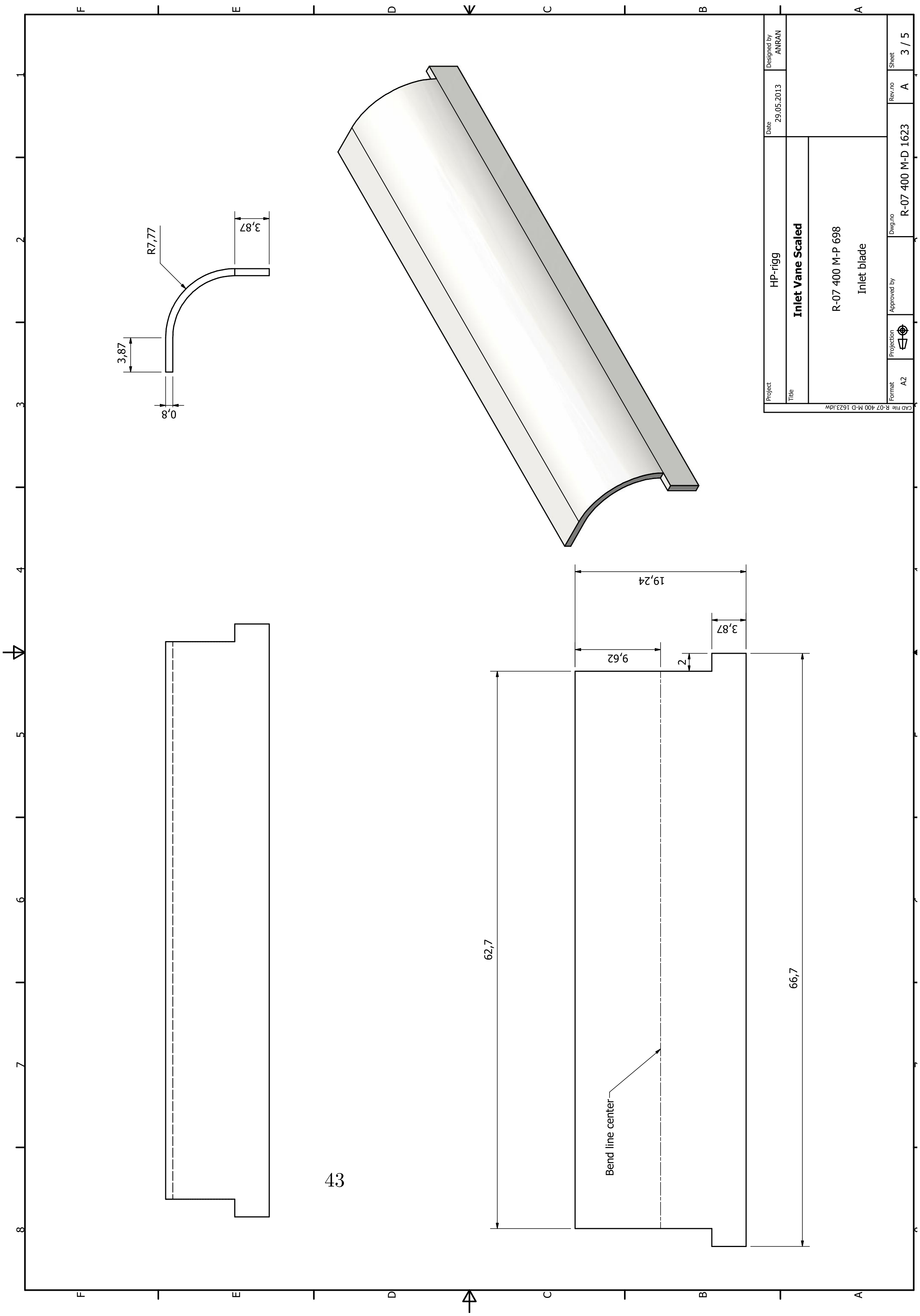
PARTS LIST

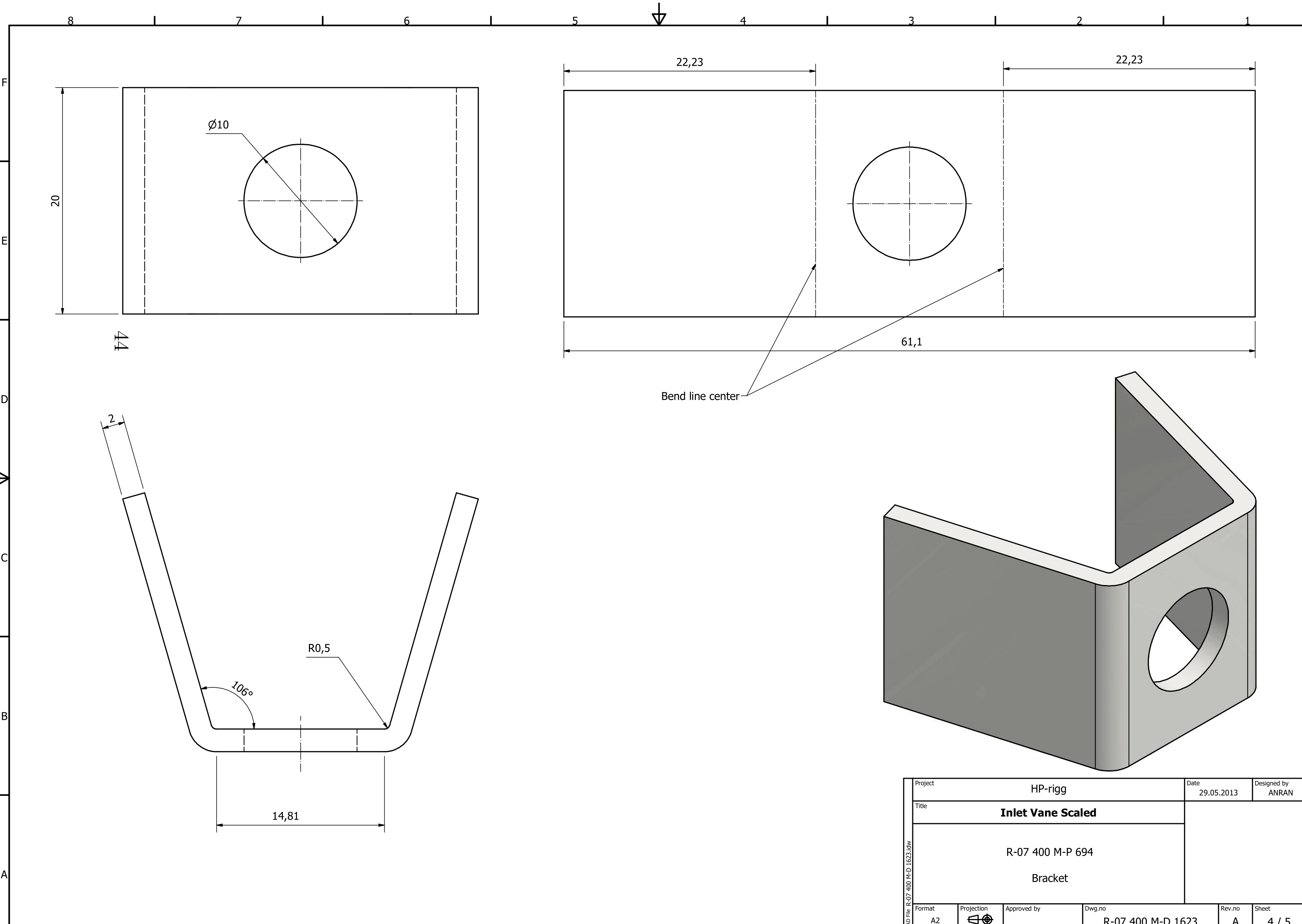
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
2	2	DIN 934 - M8	Hex Nut	Steel, Mild
3	1	O-ring 90x1	O-ring 90x1	Nitrile
4	2	R-07 400 M-P 691	Plate	Stainless Steel
5	2	R-07 400 M-P 694	Bracket	Stainless Steel
6	1	R-07 400 M-P 697	Inlet bracket	Stainless Steel
7	24	R-07 400 M-P 698	Inlet blade	Stainless Steel
11	2	DIN 933 - M8 x 90	Hex-Head Bolt	Steel, Mild

Project	HP-rigg
Date	29.05.2013
Designed by	ANRAN
Title	**Inlet Vane Scaled**
	R-07 400 M-PA 623
	INLET VANE ASSEMBLY
Format	A2
Projection	
Approved by	
Dwg.no	R-07 400 M-D 1623
Rev.no	A
Sheet	1 / 5

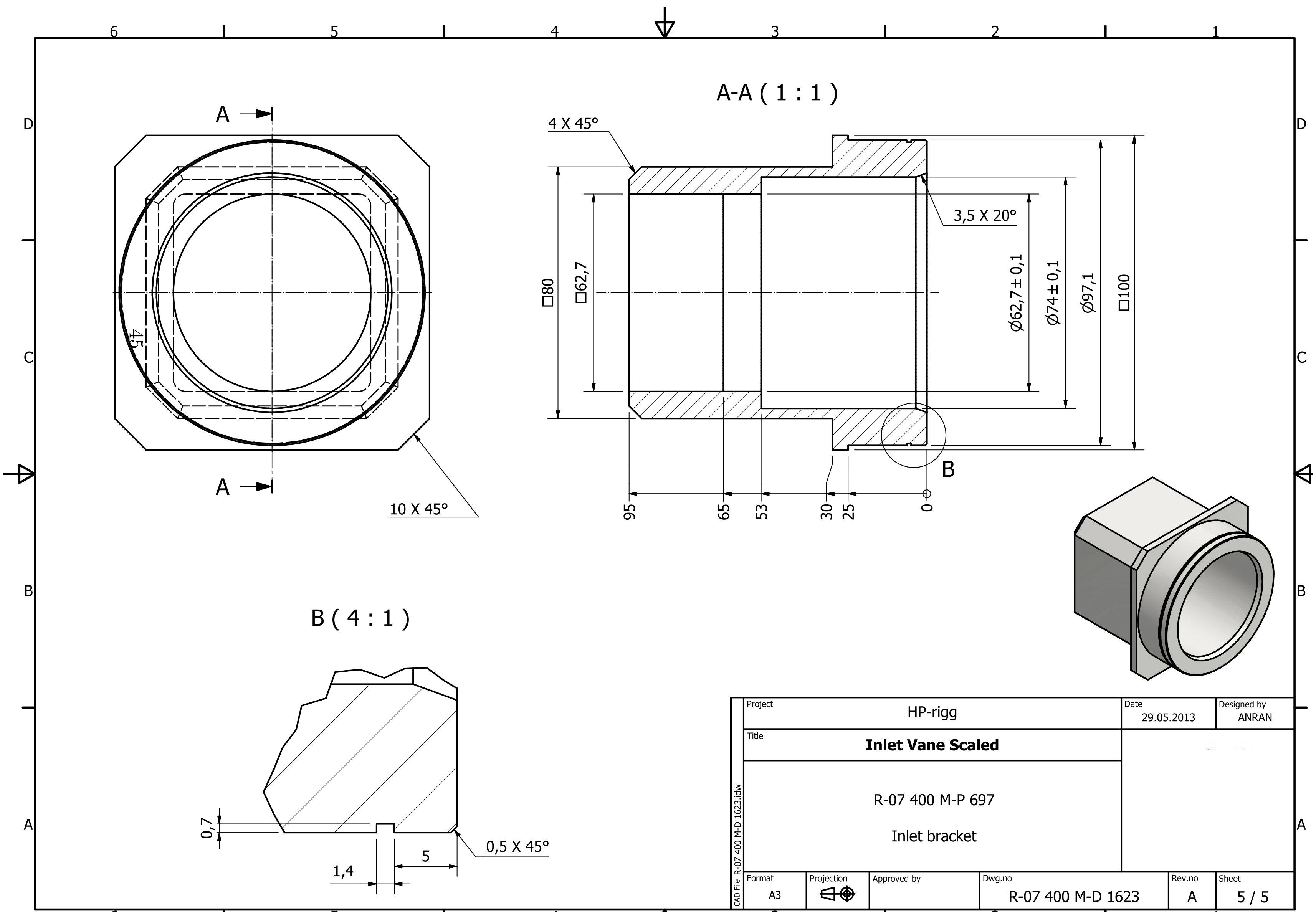
CAD File: R-07 400 M-D 1623.idw

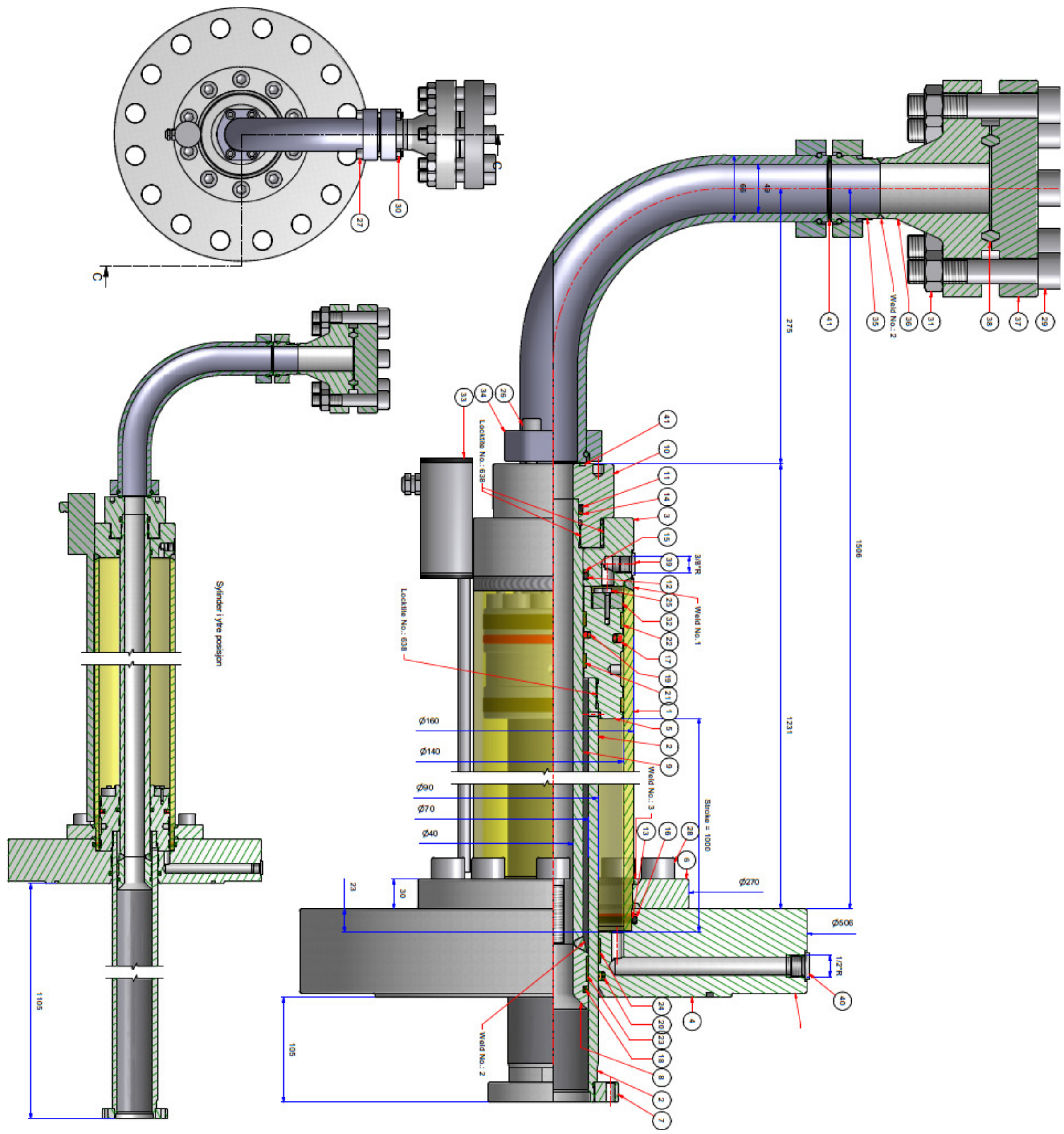

113,37
11,7
18,58
9,29
A
62,91
88,72
2
A (6 : 1)
5,08
4,18
3,22
5°
0,93
Project
HP-rigg
Date
29.05.2013
Designed by
ANRAN
Title
Inlet Vane Scaled
R-07 400 M-P 691
Plate
CAD File: R-07 400 M-D 1623.idw
Format
A2
Projection
Approved by
Dwg.no
R-07 400 M-D 1623
Rev.no
A
Sheet
2 / 5


Designed by
ANRAN
Date
29.05.2013
Project
HP-rigg
Title
Inlet Vane Scaled
R-07 400 M-P 698
Inlet blade
Approved by
Projection
Format
A2
Dwg.no
R-07 400 M-D 1623
Rev.no
A
Sheet
3 / 5
CAD File: R-07 400 M-D 1623.idw
R7,77
3,87
3,87
0,8
19,24
3,87
9,62
2
62,7
66,7
Bend line center



Ø10
20
22,23
22,23
61,1
Bend line center
2
106°
R0,5
14,81
Project
HP-rigg
Title
Inlet Vane Scaled
R-07 400 M-P 694
Bracket
Date
29.05.2013
Designed by
ANRAN
Format
A2
Projection
Approved by
Dwg.no
R-07 400 M-D 1623
Rev.no
A
Sheet
4 / 5
CAD File: R-07 400 M-D 1623.idw


A-A (1 : 1)
4 X 45°
3,5 X 20°
□80
□62,7
Ø62,7 ± 0,1
Ø74 ± 0,1
Ø97,1
□100
95
65
53
30
25
0
B
A
A
10 X 45°
B (4 : 1)
0,7
1,4
5
0,5 X 45°
Project
HP-rigg
Date
29.05.2013
Designed by
ANRAN
Title
Inlet Vane Scaled
R-07 400 M-P 697
Inlet bracket
Format
A3
Projection
Approved by
Dwg.no
R-07 400 M-D 1623
Rev.no
A
Sheet
5 / 5
CAD File R-07 400 M-D 1623.idw


Sylinder i ytre posisjon
Loctite No.: 638
Weld No.: 2
Weld No. 1
Weld No.: 3
Stroke = 1000
Ø160
Ø140
Ø90
Ø70
Ø40
Ø270
Ø506
1506
1231
275
1105
105
3/8"R
1/2"R