

Pressure drop calculation

Equipment name: - P&ID: - Item no: -

1. Introduction

Gegevens NH3 tank:

- Inhoud 250 ton;
- Materiaal: SPV315
- NH3: gas
- Druk operatie: 15,2 barg
- Ontwerpdruk: 17,6 barg
- Temperatuur: omgevingstemp.

Transport Ammoniak (NH₃)

- Huidige scope: Aanvoer NH3 per spoor vanuit OCI.
- Onderzoek voor MER: Aanvoer NH3 per buisleiding vanuit OCI.

Schets: NH3 buisleiding van OCI naar MGC

Achtergrond:

- Verbruik NH3: 30 ton per dag.
- Aandachtspunten vanuit Havenbedrijf Rotterdam (in lijn met gele cijfers in figuur)



3. Summary

| Description of section | Flow rate kg/s | Inlet pressure bara | pressure drop bar | Outlet pres. bara | Outlet velocity m/s |
|------------------------|-------------------|------------------------|----------------------|----------------------|------------------------|
| Section 1 DN25 | 0,35 | 20,00 | 37,33 | -17,33 | 1,03 |
| Section 2 DN50 | 0,35 | 17,27 | 1,07 | 16,20 | 0,27 |
| Section 3 DN100 | 0,35 | 16,24 | 0,04 | 16,20 | 0,07 |
| Section 4 DN150 | 0,35 | 16,24 | 0,04 | 16,20 | 0,07 |
| Een DN50 voldoet | | | | | |



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rev. Client: **Mitsubishi** Project: **Mitsubishi Gas Chemical MXDA plant**
 Client's Project No.: - Plant Location: **Rozenburg**



| Rev. | Date | Description/Issued for | By | Ckd. | Approved |
|------|----------|------------------------|------|------|----------|
| 0 | 12/05/20 | eerste uitgave | KLNS | | |
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Office: **Schiedam** Tebodin order: **T52892.01** Document number: **3132001** Sheet **1** of **4**

| Pressure drop calculation | | | | | | | | | | | | | |
|---|-------------------|-------------------------|----------|-------------------------|----------|-------------------------|----------|-------------------------|----------|---------------------------------|---------------------------------|----------------------------|---------|
| Equipment name: - | | | | | | | | | | P&ID: - | | Item no: - | |
| 4.1 Calculating overall resistance coefficient of section | | | | | | | | | | | | | |
| Section number | | Section 1 | | Section 2 | | Section 3 | | Section 4 | | Section 5 | | Piping | ANSI |
| Conditions at inlet | | | | | | | | | | | | | |
| F_v/F_v Flow rate | kg/s | m^3/h | 0,35 | 2,1 | 0,35 | 2,1 | 0,35 | 2,1 | 0,35 | 2,1 | 0,00 | #DIV/0! | Remarks |
| ρ/μ Density/Viscosity | kg/m ³ | mPa.s | 601,7 | 0,13 | 601,7 | 0,13 | 601,7 | 0,13 | 601,7 | 0,13 | 0,0 | 0,00 | Remarks |
| Properties pipe line | | | | | | | | | | | | | |
| Nominal size DN mm | Schedule | 25 | Std | 50 | Std | 100 | Std | 150 | Std | 150 | Std | 150 | Std |
| Out.diam. / wall thk mm | mm | 33,4 | 3,38 | 60,3 | 3,91 | 114,3 | 6,02 | 168,3 | 7,11 | 168,3 | 7,11 | 168,3 | 7,11 |
| d internal diameter pipe | mm | 26,6 | | 52,5 | | 102,3 | | 154,1 | | 154,1 | | | |
| Material and condition | - | Steel (welded), cleaned | | Steel (welded), cleaned | | Steel (welded), cleaned | | Steel (welded), cleaned | | Steel (drawn), lightly crusted | | | |
| ρ/L Roughness / Length | mm | 0,2000 | 8000,000 | 0,2000 | 8000,000 | 0,2000 | 8000,000 | 0,2000 | 8000,000 | 0,4000 | 8000,000 | 0,000 | Remarks |
| Resistance coefficient Reducer at begin of section | | | | | | | | | | | | | |
| Nominal size DN mm | Schedule | | | | | | | | | | | | |
| d / L _R Int. diam. / L reducer | mm | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Reducer at end of section | | | | | | | | | | | | | |
| Nominal size DN mm | Schedule | | | | | | | | | | | | |
| d / L _R Int. diam. / L reducer | mm | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Pipe entrance | | | | | | | | | | | | | |
| δ Angle of pipe entrance | ° | | | | | | | | | | | | |
| Entrance type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Pipe exit | | | | | | | | | | | | | |
| Exit type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Pipe exit with diffusor | | | | | | | | | | | | | |
| d ₀ Diameter outlet diffusor | mm | | | | | | | | | | | | |
| β Angle of diffusor | ° | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Ball or Gate valve, completely open | | | | | | | | | | | | | |
| d _B Bore diameter | mm | | | | | | | | | | | | |
| L _C /L _E L contract / enlargem. mm | mm | | | | | | | | | | | | |
| Valve type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Globe valve, completely open | | | | | | | | | | | | | |
| d _B Bore diameter | mm | | | | | | | | | | | | |
| Valve type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Butterfly valve, completely open | | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Plug valve, completely open | | | | | | | | | | | | | |
| d _B Bore diameter | mm | | | | | | | | | | | | |
| Valve type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Foot valve with strainer, full disc lift | | | | | | | | | | | | | |
| Valve type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| v Min. Velocity full lift / Actual | m/s | | | | | | | | | | | | |
| Resistance coefficient Check valve, full disc lift | | | | | | | | | | | | | |
| d _B Bore diameter | mm | | | | | | | | | | | | |
| Valve type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| v Min. Velocity full lift / Actual | m/s | | | | | | | | | | | | |
| Resistance coefficient Tilting disc Check valve, full disc lift | | | | | | | | | | | | | |
| α Angle | ° | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| v Min. Velocity full lift / Actual | m/s | | | | | | | | | | | | |
| Resistance coefficient Filter or strainer | | | | | | | | | | | | | |
| Filter/strainer type | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Bend | | | | | | | | | | | | | |
| R / ϕ R = r/d / Angle bend | ° | 1,5 | 90 | 1,5 | 90 | 1,5 | 90 | 1,5 | 90 | 1,5 | 90 | 1,5 | 90 |
| K Res. Coef / Number | - | 0,547 | 20 | 0,599 | 20 | 0,652 | 20 | 0,652 | 20 | 0,652 | 20 | 0,652 | 20 |
| R / ϕ R = r/d / Angle bend | ° | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Mitre Bend | | | | | | | | | | | | | |
| ϕ Angle | ° | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Mitre 90° Bend | | | | | | | | | | | | | |
| R R = r/d / Number of sections | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Tee | | | | | | | | | | | | | |
| K for Branch or Header / Flow split or mix | - | | | | | | | | | | | | |
| ϕ Ratio F _B / F _T / Angle | ° | | | | | | | | | | | | |
| d Diameter header or branch | mm | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| K for Branch or Header / Flow split or mix | - | | | | | | | | | | | | |
| ϕ Ratio F _B / F _T / Angle | ° | | | | | | | | | | | | |
| d Diameter header or branch | mm | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient "Hosenrohr" Tee (Based on main pipe) | | | | | | | | | | | | | |
| ϕ Angle | ° | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Coil | | | | | | | | | | | | | |
| d _w Diameter of coil | mm | | | | | | | | | | | | |
| Number of windings | - | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Resistance coefficient Others | | | | | | | | | | | | | |
| K Res. Coef / Number | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Remarks |
| Total Resistance coefficient | | | | | | | | | | | | | |
| K _{vF} K Valves & Fittings / % of total | - | 10,945 | 0,1 | 11,981 | 0,3 | 13,050 | 0,6 | 13,142 | 0,9 | 0,000 | #DIV/0! | Remarks | |
| f Friction factor pipe | - | 0,035 | 0,030 | 0,028 | 0,028 | error: viscosity <= 0 n | | | | | | | |
| K _{pL} K Pipe / % of total | - | 99,9 | 99,7 | 99,1 | 99,4 | 99,1 | 99,1 | 99,1 | 99,1 | 99,1 | 99,1 | 99,1 | |
| K _{rC} Total Res. Coef. of section | - | 10530,884 | 4537,809 | 2177,525 | 1470,577 | 0,000 | | | | | | | |
| Overdesign due to uncertainties in design | % | 10 | 10 | 10 | 10 | 20 | | | | | | | |
| K _T Total Res. Coef. of section | - | 11583,973 | 4991,590 | 2395,278 | 1617,634 | 0,000 | | | | | | | |
|  Client Mitsubishi Client's Project No - Project Mitsubishi Gas Chemical MXDA plant Plant Location Rozenburg | | | | | | | | | | Rev. | Date | | |
| | | | | | | | | | | 0 | 12/05/20 | | |
| Office: Schiedam | | | | | | | | | | Tebedin order: T52892.01 | Document number: 3132001 | Sheet 2 of 4 | |

Pressure drop calculation

Equipment name : - P&ID : - Item no: -


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|----|--|-------------------|--|-----------|-----------|----------------|
| 1 | | | | | | |
| 2 | 4.2 Calculating pressure drop of section | | | | | |
| 3 | | | | | | |
| 4 | Description of section | | Source & Comments: Physical properties and inlet conditions | | | |
| 5 | Section 1 | DN25 | | | | |
| 6 | Section 2 | DN50 | | | | |
| 7 | Section 3 | DN100 | | | | |
| 8 | Section 4 | DN150 | | | | |
| 9 | Section 5 | Pipe 5 | | | | |
| 10 | | | | | | |
| 11 | Section number | Section 1 | Section 2 | Section 3 | Section 4 | Section 5 |
| 12 | Properties pipe line | | | | | Remarks |
| 13 | ε Absolute roughness pipe | mm | 0,20 | 0,20 | 0,20 | 0,20 |
| 14 | d _p Diameter pipe | mm | 26,65 | 52,50 | 102,26 | 154,05 |
| 15 | K Resistance coefficient | - | 11583,97 | 4991,59 | 2395,28 | 1617,63 |
| 16 | Properties fluid | | | | | Remarks |
| 17 | Medium (Gas or Liquid) | | Liquid | Liquid | Liquid | Liquid |
| 18 | μ viscosity | mPa.s | 0,131 | 0,131 | 0,131 | 0,131 |
| 19 | k isentropic exponent C _p /C _v | - | | | | |
| 20 | T _C Critical temperature | °C | | | | |
| 21 | P _C Critical pressure | bara | | | | |
| 22 | ω Acentric factor | - | | | | wikipedia |
| 23 | M Molweight | gr/mol | 17,03 | 17,03 | 17,03 | 17,03 |
| 24 | ρ Density | kg/m ³ | 601,69 | 601,69 | 601,69 | 601,69 |
| 25 | Conditions at inlet | | | | | Remarks |
| 26 | T Temperature | °C | 25,00 | 25,00 | 25,00 | 25,00 |
| 27 | P Pressure | bara | 20,00 | 17,27 | 16,24 | 16,20 |
| 28 | F _M Flow rate | kg/s | 0,35 | 0,35 | 0,35 | 0,35 |
| 29 | Maximum flow rate | kg/s | | | | |
| 30 | F _V | m ³ /h | 2,08 | 2,08 | 2,08 | 2,08 |
| 31 | z Compressibility | - | | | | |
| 32 | ρ Density | kg/m ³ | 601,69 | 601,69 | 601,69 | 601,69 |
| 33 | Dynamic pressure drop | | | | | Remarks |
| 34 | P _{IN} Pressure at inlet | bara | 20,00 | 17,27 | 16,24 | 16,20 |
| 35 | z _{IN} Compressibility | - | | | | |
| 36 | ρ _{IN} Density | kg/m ³ | 601,69 | 601,69 | 601,69 | 601,69 |
| 37 | v _{IN} Velocity | m/s | 1,03 | 0,27 | 0,07 | 0,03 |
| 38 | N _{RE} Reynolds | - | 126539 | 64219 | 32971 | 21887 |
| 39 | f _{IN} Darcy friction factor | - | 0,0350 | 0,0297 | 0,0277 | 0,0281 |
| 40 | MA _{IN} Mach number | - | | | | |
| 41 | MA _{CH} Mach choked | - | | | | |
| 42 | P _{OUT} Pressure at outlet | bara | -17,33 | 16,20 | 16,20 | 16,20 |
| 43 | z _{OUT} Compressibility | - | | | | |
| 44 | ρ _{OUT} Density | kg/m ³ | 601,69 | 601,69 | 601,69 | 601,69 |
| 45 | v _{OUT} Velocity | m/s | 1,03 | 0,27 | 0,07 | 0,03 |
| 46 | N _{RE} Reynolds | - | 126539 | 64219 | 32971 | 21887 |
| 47 | f _{OUT} Darcy friction factor | - | 0,0350 | 0,0297 | 0,0277 | 0,0281 |
| 48 | MA _{OUT} Mach number | - | | | | |
| 49 | MA _{CH} Mach choked | - | | | | |
| 50 | dP _{DYN} Dynamic pressure drop | bar | 37,327 | 1,067 | 0,036 | 0,005 |
| 51 | Static pressure drop | | | | | Remarks |
| 52 | ρ _{IN} Density | kg/m ³ | 601,69 | 601,69 | 601,69 | 601,69 |
| 53 | H Dif. in height: outlet - inlet | m | 0,00 | 0,00 | 0,00 | 0,00 |
| 54 | dP _{ST} Static Pres.drop | bar | 0,000 | 0,000 | 0,000 | 0,000 |
| 55 | Summary | | | | | Remarks |
| 56 | P _{IN} Inlet pressure | bara | 20,00 | 17,27 | 16,24 | 16,20 |
| 57 | dP _{DYN} Dynamic pressure drop | bar | 37,33 | 1,07 | 0,04 | 0,00 |
| 58 | dP _{ST} Static Pres.drop | bar | 0,00 | 0,00 | 0,00 | 0,00 |
| 59 | dP _{TOT} Total pressure drop | bar | 37,33 | 1,07 | 0,04 | 0,00 |
| 60 | P _{OUT} Outlet pressure | bara | -17,33 | 16,20 | 16,20 | 16,20 |
| 61 | | | | | | |
| 62 | Remarks | | | | | |
| 63 | | | | | | |
| 64 | kookpunt ammonia @ atm: | -33,43 °C | | | | |
| 65 | dampdruk ammonia @ 25°C: | 10,01 bara | | | | |
| 66 | druk in ontvangstank: | 15,20 barg | | | | |
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|  BILFINGER | Client | Mitsubishi | Rev. | Date | | | | | |
| | Client's Project No | - | 0 | 12/05/20 | | | | | |
| | Project | Mitsubishi Gas Chemical MXDA plant | | | | | | | |
| | Plant Location | Rozenburg | | | | | | | |
| Office: | Schiedam | Tebodin order: | T52892.01 | Document number : | 3132001 | Sheet | 3 | of | 4 |

Pressure drop calculation

Equipment name: - P&ID: - Item no: -

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| 2 | 4.3 Other pressure drop calculations |
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|---|---------------------------------|---|----------------|-------------|
|  BiLFINGER | Client | Mitsubishi | Rev. | Date |
| | Client's Project No | - | 0 | 12/05/20 |
| | Project | Mitsubishi Gas Chemical MXDA plant | | |
| | Plant Location | Rozenburg | | |
| Office: Schiedam | Tebodin order: T52892.01 | Document number: 3132001 | Sheet 4 | of 4 |