ROCKSENSOR™

# Thermal Mass Flow Meter

## RF3700


- Integrated/ Remote Transmitter Working
- Accuracy of ±0.5%
- Square wave plus, 4-20mA signal output
- IP65 Enclosure Protection

**Product Datasheet**

# ROCKSENSOR AT A GLANCE (ABOUT US)

Rocksensor is one of the global leaders specializing in Process Instrumentation, Research and Development and Designing of Industrial Automation Equipment. We provide highly precise pressure sensors and transmitters, flow metres, level transmitters and temperature transmitters with a prime focus to help our clients efficiently, safely and economically run complex industrial processes.

Rocksensor, headquartered in Switzerland, has its footprint in various geographical regions such as the US, Russia, South Korea, Italy, Germany, Singapore, Malaysia, Morocco, China, Taiwan, Australia, UAE, Brazil and India. Our clients come from some of the major industries such as Oil and Gas, Petrochemicals, Pharmaceuticals, FMCG, Automobiles, Water, Cement, Metal & Mining, and mainly from the Power Industry like Nuclear, Thermal, Hydro, and Solar.

Rocksensor deals in a wide range of highly accurate industrial automation instruments ensuring that even the complex industrial processes happen efficiently.

To fulfill the needs of our clients we make sure that our instruments work in even the harsh environmental conditions offering accurate recordings and communication.

We, at Rocksensor, believe in creating bonds that last a lifetime and create a success story for each and every client. Rocksensor aims to achieve a perfect fit in the global market landscape and establish our footprints across the globe.

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## KEY APPLICATION INDUSTRIES

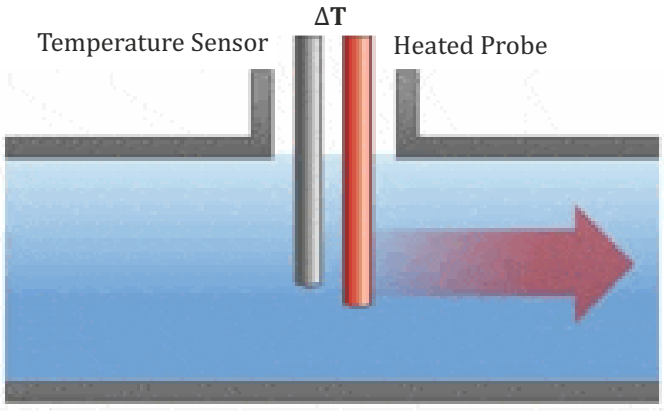
- Oil and Gas sector
- Cement
- Metal
- Pulp and Paper
- Agriculture
- Textiles
- Chemicals
- Power
- Water
- Pharmaceutical
- Fertilizer
- Plastics and HVAC

## 1. Introduction

Thermal mass flow meters, also known as thermal dispersion or immersible mass flow meters comprise a family of instruments for the measurement of the total mass flow rate of a fluid, primarily gases, flowing through closed conduits. Thermal gas mass flow meter is designed on the basis of thermal dispersion, and adopts method of constant differential temperature to measure gas flow. It has advantages of small size, easy installation, high reliability and high accuracy, etc.

## 2. Working Principle

Thermal flow meters use the thermal properties of the gases to measure the flow of a gas flowing in a pipe or duct. The flowmeter contains two platinum resistance temperature sensors. The thermal flow meter operates by monitoring the cooling effect of a gas stream as it passes over a heated sensor. Gas flowing through the sensing section passes over two sensors one of which is used conventionally as a temperature sensor, while other is used as a heater. The temperature sensor monitors the actual process values while the heater is maintained at a constant differential temperature. The greater the gas velocity, the greater the cooling effect and power required to maintain the differential temperature. The measurement of heater power is therefore a measurement of the gas mass flow rate.




$$m = \frac{Kq}{(Cp(T_2 - T_1))}$$

The mass flow (m) is calculated on the basis of the measured temperature difference ($T_2 - T_1$), the meter coefficient (K), the electric heat rate (q), and the specific heat of the fluid (Cp).

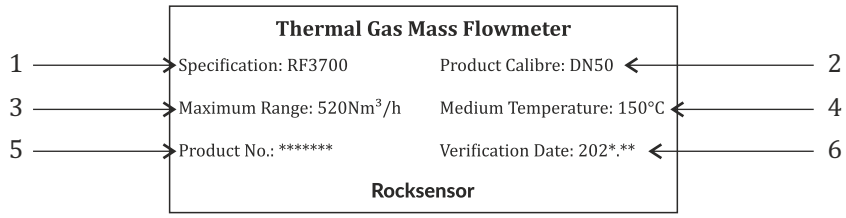
## 3. Features

- Compact size, easy installation, high reliability and high accuracy
- Can be used for gas leak detection
- Reference accuracy up to ±1%
- Configuration with RS485 or HART Interfaces
- Available in Insertion and Flange Connection Type
- No need for temperature or pressure compensation
- Good vibration resistance, no moving parts
- Standard 4-20 mADC Analog/ Pulse Output
- Suitable for medium temperature up to 350° C

## 4. Key Applications

- Clean gases
- Nitrogen
- Helium
- Argon
- Air
- Hydrogen
- Ammonia
- Other industrial gas

# 5. Identification




1. Specifications
2. Line Size
3. Maximum Range
4. Medium Temperature
5. Product Serial Number
6. Verification Date

# 6. Technical Specifications

| Performance | Technical Parameters | |
|---|---|---|
| Parameter | Gas (Except Acetylene) | |
| Line Sizes | DN80 ~ DN4000 (Insertion) | DN10 ~ DN2000 (Flange) |
| Velocity | 0.5 ~ 100 N m/s (20°C, 101.33kPa) | |
| Accuracy | ±2.5%/ ±1.5% Reading (Insertion) | ±1% Reading (Flange) |
| Response Time | 1s | |
| Output | Pulse/ 4-20 mADC (Max. Load 500Ω) | |
| Power Supply | Compact: 24VDC or 220VAC; Power Consumption: ≤18W<br>Remote Type: 220VAC; Power Consumption: ≤19W | |
| Working Pressure | Insertion: ≤2.5MPa | Flange: ≤4.0MPa |
| $T_{Ambient}$ | (-)20°C ~ 50°C | |
| $T_{Medium}$ | (-)20°C ~ 150°C | |
| Housing | SS304 or SS316 | |
| Sensor Material | SS, CS | |
| Ingress Protection | IP65/ Explosion Proof | |
| Communication | RS485, HART | |
| Display | 4 Digit LCD, Mass Flow, Volume Flow, Flow Totalizer, etc. | |
| Alarm Output | 1-2 Line Relay, Normally open, 10A/220VAC or 5A/30VDC | |

| | | |
|---|---|---|
| Structure Type | Plug-in/ Pipeline/ Inline/ Insertion Type | |
| Measuring Medium | Common steady-state gases (unstable media such as acetylene and boron trichloride are not measurable) | |
| Pipe Diameter Range | DN65 ~ 4000mm | DN15 ~ 2000mm |
| Flow Rate Range | 0.1 ~ 120Nm/s | |
| Accuracy | ±1 ~ 2.5% | |
| Operating Temperature | Sensor: (-)40 ~ 450°C; Converter: (-)20 ~ 45°C | |
| Working Pressure | Medium pressure ≤ 4.0Mpa<br>(≥ 4.0Mpa Agreement supply) | Medium pressure ≤ 1.6MPa<br>(≥ 4.0MPa Agreement supply) |
| Power Supply | (DC 24V )>=18W | |
| Responding Speed | 1s | |
| Output Signal | 4-20mA (Optical isolation, Maximum load 500Ω, RS-485(Lightning protection)) | |
| Call the Police | 1-2 normally open contacts, 24V/0.5A | |
| Type of Supply | Integrated Structure | |
| Pipe Material | Carbon steel, stainless steel, plastic, etc. | |
| Live Display | Four-line LCD display | |
| Display Content | Mass flow rate, standard volume flow rate, cumulative flow rate, standard flow rate, etc. | |
| Protection Level | IP65, IP67, IP68 | |
| Sensor Material | Stainless steel | Stainless steel, carbon steel |

# 7. Dimensional Drawings

**1. Flange Mounting Size** (Unit: mm)

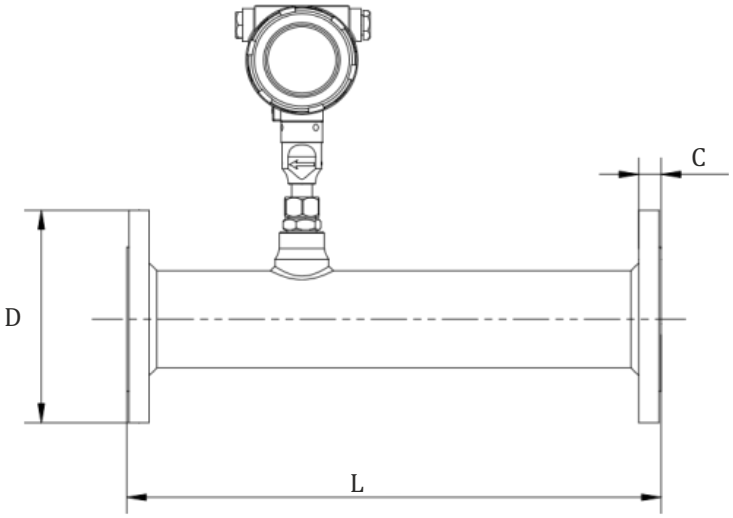



**Figure 1**

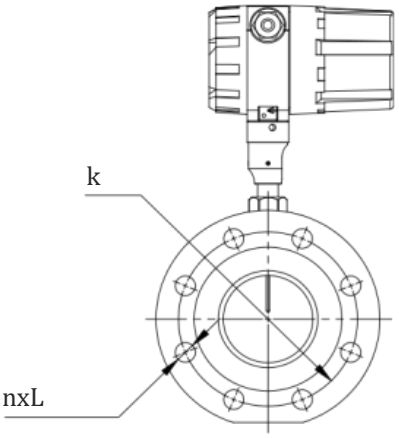
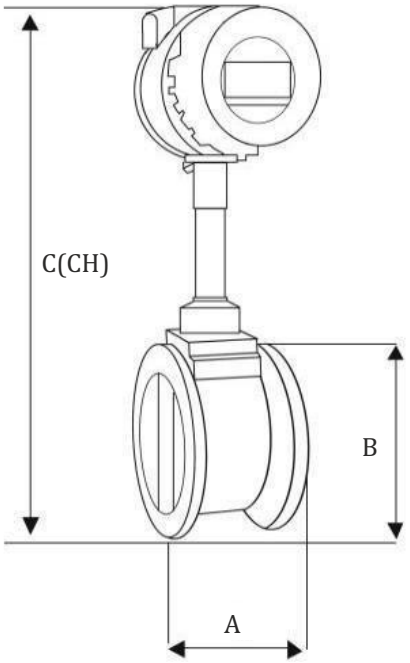



**Figure 2**

GB/T9119-2000 PN1.6Mpa(16bar) Flat, protruding panel flat welded steel pipe flange

| Nominal Diameter | Flange Outer Diameter | Center Hole Diameter | Screw Hole | Thread Specification | Flange Thickness | Instrument Installation Length |
|---|---|---|---|---|---|---|
| DN | D | K | n*L | | C | L |
| 15 | 95 | 65 | 4*14 | M12 | 12 | 160 |
| 20 | 105 | 75 | 4*14 | M12 | 14 | 160 |
| 25 | 115 | 85 | 4*14 | M12 | 14 | 160 |
| 32 | 140 | 100 | 4*18 | M16 | 16 | 160 |
| 40 | 150 | 110 | 4*18 | M16 | 16 | 180 |
| 50 | 165 | 125 | 4*18 | M16 | 18 | 180 |
| 65 | 185 | 145 | 4*18 | M16 | 20 | 180 |
| 80 | 200 | 160 | 8*18 | M16 | 20 | 180 |
| 100 | 220 | 180 | 8*18 | M16 | 20 | 200 |
| 125 | 250 | 210 | 8*18 | M16 | 20 | 200 |
| 150 | 285 | 240 | 8*22 | M20 | 22 | 200 |
| 200 | 340 | 295 | 12*22 | M20 | 22 | 200 |
| 250 | 405 | 355 | 12*26 | M24 | 24 | 200 |
| 300 | 460 | 410 | 12*26 | M24 | 24 | 200 |

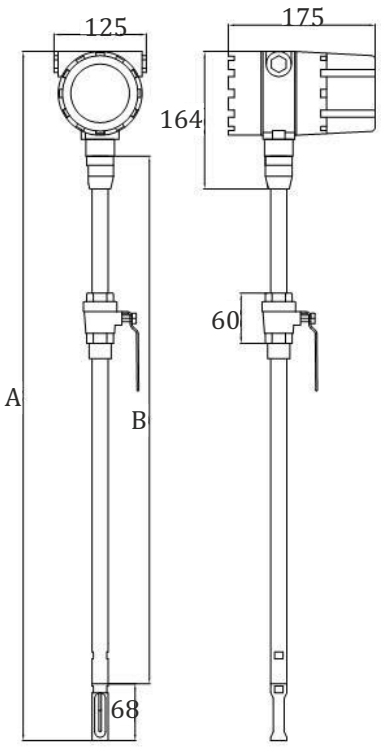
**2. Card Mounted Mounting Size** (Unit: mm)




- For DN15 ~ DN80 can be used pipe thread connection.
- Only the maximum rated pressure data of 1.6Mpa is given in the table, and it can be customized above the rated pressure.
- The integral full tube can be flanged, threaded and snap-fit.

| Caliber DN | B | (CH) | A |
|---|---|---|---|
| 15-25 | 55 | 390(455) | 70 |
| 32 | 55 | 390(455) | 70 |
| 40 | 80 | 385(440) | 85 |
| 50 | 90 | 390(450) | 85 |
| 65 | 105 | 400(470) | 85 |
| 80 | 120 | 420(480) | 85 |
| 100 | 140 | 440(500) | 85 |
| 125 | 165 | 465(530) | 90 |
| 150 | 194 | 490(560) | 100 |
| 200 | 248 | 545(610) | 102 |
| 250 | 300 | 595(650) | 115 |
| 300 | 350 | 645(710) | 130 |

**3. Plug-in Mounting Size** (Unit: mm)




| Caliber | Base range (air) ($Nm^3/h$) | Extended range (air) ($Nm^3/h$) | Oxygen base range ($Nm^3/h$) | Combustible gas range ($Nm^3/h$) |
|---|---|---|---|---|
| 10 | 0.5 ~ 28 | 0.03 ~ 30 | 0.5 ~ 14 | 0.5 ~ 5 |
| 15 | 0.5 ~ 65 | 0.07 ~ 65 | 0.5 ~ 32 | 0.5 ~ 10 |
| 20 | 0.5 ~ 100 | 0.12 ~ 110 | 0.5 ~ 55 | 0.5 ~ 20 |
| 25 | 0.5 ~ 175 | 0.18 ~ 180 | 0.5 ~ 89 | 0.5 ~ 28 |
| 32 | 0.5 ~ 290 | 0.3 ~ 290 | 0.5 ~ 144 | 0.5 ~ 45 |
| 40 | 0.5 ~ 450 | 0.5 ~ 450 | 0.5 ~ 226 | 0.5 ~ 70 |
| 50 | 1 ~ 600 | 0.5 ~ 700 | 0.7 ~ 352 | 0.7 ~ 110 |
| 65 | 1.5 ~ 1000 | 1 ~ 1200 | 1.2 ~ 600 | 1.2 ~ 185 |
| 80 | 2 ~ 1500 | 1.5 ~ 1800 | 2 ~ 900 | 2 ~ 280 |
| 100 | 3 ~ 2300 | 3 ~ 2800 | 3 ~ 1420 | 3 ~ 470 |
| 125 | 4.5 ~ 3500 | 4 ~ 4400 | 4.5 ~ 2210 | 4.5 ~ 700 |
| 150 | 6.5 ~ 5200 | 6 ~ 6300 | 6.5 ~ 3200 | 6.5 ~ 940 |
| 200 | 12 ~ 9000 | 12 ~ 11500 | 12 ~ 5650 | 12 ~ 1880 |
| 250 | 18 ~ 14500 | 18 ~ 17500 | 18 ~ 8830 | 18 ~ 2820 |
| 300 | 25 ~ 21000 | 25 ~ 25000 | 25 ~ 12720 | 25 ~ 4060 |
| 350 | 35 ~ 28000 | 35 ~ 34500 | 35 ~ 17000 | 35 ~ 5600 |
| 400 | 45 ~ 36500 | 45 ~ 45000 | 45 ~ 22600 | 45 ~ 7200 |
| 450 | 60 ~ 46500 | 60 ~ 57000 | 60 ~ 29000 | 60 ~ 9200 |
| 500 | 70 ~ 57000 | 70 ~ 70000 | 70 ~ 35300 | 70 ~ 11280 |
| 600 | 100 ~ 81000 | 100 ~ 101000 | 100 ~ 50600 | 100 ~ 16300 |
| 700 | 140 ~ 110000 | 140 ~ 138000 | 140 ~ 69000 | 140 ~ 22100 |
| 800 | 180 ~ 150000 | 180 ~ 180000 | 180 ~ 90000 | 180 ~ 29000 |
| 900 | 230 ~ 185000 | 230 ~ 230000 | 230 ~ 115000 | 230 ~ 36500 |
| 1000 | 290 ~ 230000 | 290 ~ 280000 | 290 ~ 140000 | 290 ~ 45500 |
| 2000 | 1150 ~ 900000 | 1150 ~ 1130000 | 1150 ~ 560000 | 1150 ~ 185000 |

• The integral plug-in type should be inserted into the axis of the pipe to be tested, so the length of the measuring rod depends on the diameter of the measuring pipe. It should be stated when ordering.

• If it cannot be inserted into the pipe axis, the factory will provide the calibration factor to complete the accurate measurement.

## 8. Model Selection Table

| RF3500 | Thermal Mass Flow Meter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Code | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

| Line Size (DN) | |
|---|---|
| DN10 ~ DN4000 | Standard Line Sizes |

| Structure | |
|---|---|
| Compact | C |
| Remote | R |

| Sensor Type | |
|---|---|
| Insertion | I |
| Flange | F |
| Clamp | C |
| Screw/ Thread | S |

| Material | |
|---|---|
| SS304 | 304 |
| SS316 | 316 |

| Signal Output | |
|---|---|
| RS | 4-20 mA + Pulse + RS485 |
| HT | 4-20 mA + Pulse + HART |

| Power Supply | |
|---|---|
| AC | AC 85-250V |
| DC | DC 20-36V |

| Working Temperature | |
|---|---|
| T1 | (-)20°C ~ 150°C |

| Working Pressure | |
|---|---|
| 16 | 1.6 MPa |
| 25 | 2.5 MPa |
| 40 | 4.0 MPa |

**Example:** RF3500-30CI30416T1ACRS

30 - Line Size (DN): DN30

C - Structure: Compact

I - Sensor Type: Insertion

304 - Material: SS304

16 - Working Pressure: 1.6MPa

T1 - Working Temperature: (-)20°C ~ 150°C

AC - Power Supply: AC 85-250V

RS: Signal Output: 4-20mA + Pulse + RS485

*For any customisation, contact our sales team

# Appendix 1: The Density and Conversion Coefficient of Common Gas

According to different gas on site, the calibration in lab translates the flow rate of actual gas on site into flow of air & then begins to calibrate the flow rate at present. Therefore, when using the meter on site, the meter displays mass flow/ volume flow of actual gas. When converting the flow rate of gas into flow rate of air, there is a conversion coefficient table of different gases.

| Sr. No. | Gas Name | Specific Heat (Cal/g/°C) | Density (g/l, 0°C) | Conversion Coefficient |
|---|---|---|---|---|
| 1. | Air | 0.24 | 1.2048 | 1.0000 |
| 2. | Argon (Ar) | 0.125 | 1.6605 | 1.4066 |
| 3. | Arsine ($AsH_3$) | 0.1168 | 3.478 | 0.6690 |
| 4. | Boron Tribromide ($BBr_3$) | 0.0647 | 11.18 | 0.3758 |
| 5. | Boron Trichloride ($BCl_3$) | 0.1217 | 5.227 | 0.4274 |
| 6. | Boron Trifluoride ($BF_3$) | 0.1779 | 3.025 | 0.5050 |
| 7. | Borane ($B_2H_6$) | 0.502 | 1.235 | 0.4384 |
| 8. | Carbon Tetrachloride ($CCl_4$) | 0.1297 | 6.86 | 0.3052 |
| 9. | Carbon Tetrafluoride ($CF_4$) | 0.1659 | 3.9636 | 0.4255 |
| 10. | Methane ($CH_4$) | 0.5318 | 0.715 | 0.7147 |
| 11. | Acetylene ($C_2H_2$) | 0.4049 | 1.162 | 0.5775 |
| 12. | Ethylene ($C_2H_4$) | 0.3658 | 1.251 | 0.5944 |
| 13. | Ethane ($C_2H_6$) | 0.4241 | 1.342 | 0.4781 |
| 14. | Allylene ($C_3H_4$) | 0.3633 | 1.787 | 0.4185 |
| 15. | Propylene ($C_3H_6$) | 0.3659 | 1.877 | 0.3956 |
| 16. | Propane ($C_3H_8$) | 0.399 | 1.967 | 0.3459 |
| 17. | Butyne ($C_4H_6$) | 0.3515 | 2.413 | 0.3201 |
| 18. | Butene ($C_4H_8$) | 0.3723 | 2.503 | 0.2923 |
| 19. | Butane ($C_4H_{10}$) | 0.413 | 2.593 | 0.2535 |
| 20. | Pentane ($C_5H_{12}$) | 0.3916 | 3.219 | 0.2157 |
| 21. | Carbinol ($CH_3OH$) | 0.3277 | 1.43 | 0.5805 |
| 22. | Ethanol ($C_2H_6O$) | 0.3398 | 2.055 | 0.3897 |
| 23. | Trichloroethane ($C_3H_3Cl_3$) | 0.1654 | 5.95 | 0.2763 |
| 24. | Carbon Monoxide (CO) | 0.2488 | 1.25 | 0.9940 |
| 25. | Carbon Dioxide ($CO_2$) | 0.2017 | 1.964 | 0.7326 |
| 26. | Cyanide ($C_2N_2$) | 0.2608 | 2.322 | 0.4493 |
| 27. | Chlorine ($Cl_2$) | 0.1145 | 3.163 | 0.8529 |
| 28. | Deuterium ($D_2$) | 1.7325 | 0.1798 | 0.9921 |
| 29. | Fluoride ($F_2$) | 0.197 | 1.695 | 0.9255 |
| 30. | Germanium Tetrachloride ($GeCl_4$) | 0.1072 | 9.565 | 0.2654 |
| 31. | Germane ($GeH_4$) | 0.1405 | 3.418 | 0.5656 |
| 32. | Hydrogen ($H_2$) | 3.4224 | 0.0899 | 1.0040 |
| 33. | Hydrogen Bromide (HBr) | 0.0861 | 3.61 | 0.9940 |
| 34. | Hydrogen Chloride (HCl) | 0.1911 | 1.627 | 0.9940 |
| 35. | Hydrogen Fluoride (HF) | 0.3482 | 0.893 | 0.9940 |
| 36. | Hydrogen Iodide (HI) | 0.0545 | 5.707 | 0.9930 |
| 37. | Hydrogen Sulphide ($H_2S$) | 0.2278 | 1.52 | 0.8390 |
| 38. | Helium (He) | 1.2418 | 0.1786 | 1.4066 |
| 39. | Krypton (Kr) | 0.0593 | 3.739 | 1.4066 |
| 40. | Nitrogen ($N_2$) | 0.2486 | 1.25 | 0.9940 |
| 41. | Neon (Ne) | 0.2464 | 0.9 | 1.4066 |
| 42. | Ammonia ($NH_3$) | 0.5005 | 0.76 | 0.7147 |
| 43. | Nitric Oxide (NO) | 0.2378 | 1.339 | 0.9702 |
| 44. | Nitrogen Dioxide ($NO_2$) | 0.1923 | 2.052 | 0.7366 |
| 45. | Nitrous Oxide ($N_2O$) | 0.2098 | 1.964 | 0.7048 |
| 46. | Oxygen ($O_2$) | 0.2196 | 1.427 | 0.9861 |
| 47. | Phosphorous Trichloride ($PCl_3$) | 0.1247 | 6.127 | 0.3559 |

| | | | | |
|---|---|---|---|---|
| 48. | Phophorane ($PH_3$) | 0.261 | 1.517 | 0.6869 |
| 49. | Phosphorous Pentaflouride ($PF_5$) | 0.1611 | 5.62 | 0.3002 |
| 50. | Phosphorous Oxychloride ($POCl_3$) | 0.1324 | 6.845 | 0.3002 |
| 51. | Silicon Tetrachloride ($SiCl_4$) | 0.127 | 7.5847 | 0.2823 |
| 52. | Silicon Fluoride ($SiF_4$) | 0.1692 | 4.643 | 0.3817 |
| 53. | Silane ($SiH_4$) | 0.3189 | 1.433 | 0.5954 |
| 54. | Dichlorosilane ($SiH_2Cl_2$) | 0.1472 | 4.506 | 0.4095 |
| 55. | Tricholorosilane ($SiHCl_3$) | 0.1332 | 6.043 | 0.3380 |
| 56. | Sulphur Hexafluoride ($SF_6$) | 0.1588 | 6.516 | 0.2624 |
| 57. | Sulphur Dioxide ($SO_2$) | 0.1489 | 2.858 | 0.6829 |
| 58. | Titanium Tetracholide (TiCl4) | 0.1572 | 8.465 | 0.2048 |
| 59. | Tungsten Hexafluoride ($WF_6$) | 0.0956 | 13.29 | 0.2137 |
| 60. | Xenon (Xe) | 0.0379 | 5.858 | 1.4066 |

## Appendix 2: Upper Range Value of Common Gases

(Unit: $Nm^3/h$. The following table can be extended)

| Nominal Diameter (mm) | Air | Nitrogen ($N_2$) | Oxygen ($O_2$) | Hydrogen ($H_2$) |
|---|---|---|---|---|
| 15 | 65 | 65 | 32 | 10 |
| 25 | 175 | 175 | 89 | 28 |
| 32 | 290 | 290 | 144 | 45 |
| 40 | 450 | 450 | 226 | 70 |
| 50 | 700 | 700 | 352 | 110 |
| 65 | 1200 | 1200 | 600 | 185 |
| 80 | 1800 | 1800 | 900 | 280 |
| 100 | 2800 | 2800 | 1420 | 470 |
| 125 | 4400 | 4400 | 2210 | 700 |
| 150 | 6300 | 6300 | 3200 | 940 |
| 200 | 10000 | 10000 | 5650 | 1880 |
| 250 | 17000 | 17000 | 8830 | 2820 |
| 300 | 25000 | 25000 | 12720 | 4060 |
| 400 | 45000 | 45000 | 22608 | 7200 |
| 500 | 70000 | 70000 | 35325 | 11280 |
| 600 | 100000 | 100000 | 50638 | 16300 |
| 700 | 135000 | 135000 | 69240 | 22100 |
| 800 | 180000 | 180000 | 90432 | 29000 |
| 900 | 220000 | 220000 | 114500 | 77807 |
| 1000 | 280000 | 280000 | 141300 | 81120 |
| 1200 | 400000 | 400000 | 203480 | 91972 |
| 1500 | 600000 | 600000 | 318000 | 101520 |
| 2000 | 700000 | 700000 | 565200 | 180480 |

- The above flowrate is in standard condition at 20°C Temperature and 101.325 kPa Pressure.
- The other flowrate unit options are: $Nm^3/h$, $Nm^3/min$, L/h, L/min, t/h, t/min, kg/h or kg/min.
- Equation for flowrate correlating the Working Flowrate and Standard Flowrate:

$$Q_s = \frac{0.101325 + p}{0.101325} \times \frac{273.15 + 20}{273.15 + t} \times Q_n$$

$Q_s$ = Flow rate in standard condition ($Nm^3/h$)

$Q_n$ = Flow rate in working condition ($m^3/h$).

t = Medium temperature in working condition (°C)

p = Medium pressure in working condition (Gauge pressure, kPa)