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	ISI (Dubai, UAE) = 0.829	РИНЦ (Russia) = 0.207	PIF (India) = 1.940
	GIF (Australia) = 0.564	ESJI (KZ) = 4.102	IBI (India) = 4.260
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Denis Chemezov
M.Sc.Eng., Corresponding Member of International Academy of Theoretical and Applied Sciences, Lecturer of Vladimir Industrial College, Russian Federation
chemezov-da@yandex.ru

Tatyana Lukyanova
Lecturer of Vladimir Industrial College, Russian Federation

SECTION 2. Applied mathematics. Mathematical modeling.

AERODYNAMIC AND HYDRODYNAMIC FLOW PARAMETERS OF GASES AND LIQUIDS

Abstract: *Changes of the parameters values of transient flow of gases and liquids when increasing pressure are presented in the article. Comparison of densities, flow velocities, vorticities, dynamic pressures, the Prandtl numbers, turbulent energies and other motion parameters of liquids and gases was performed.*

Key words: *liquid, gas, flow.*

Language: *English*

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Introduction

In the work [1] it is given representation about character of water flow in a straight pipeline. Transient flow is characterized by vortices formation of different intensity in fluid [2]. Flow of liquids and gases in a some volume in large part has the same character. However, a change of density during flow (filling of the volume) of gases leads to a significant increasing of pressure, temperature, flow velocity, vorticity and etc. Density of liquid is almost constant and values of hydrodynamic parameters will depend on value of fluid movement per unit time and a cross sectional area of the pipeline. In this article by a numerical simulation there were defined aerodynamic and hydrodynamic parameters of transient flow of liquids and gases. These calculated values of parameters will allow to choose material, overall dimensions and other characteristics of a device for transporting of fluids.

Materials and methods

Aerodynamic and hydrodynamic parameters of liquids and gases and their dependencies when increasing of pressure are determined. For research there were taken the following fluids:

1. Acetone (liquid and gas);
2. Air (gas);
3. Ammonia (liquid and gas);
4. Argon (liquid and gas);
5. Butane (gas);
6. Carbon dioxide (gas);
7. Chlorine (gas);
8. Ethane (liquid and gas);
9. Ethanol (liquid and gas);
10. Ethylene (liquid and gas);
11. Fluorine (gas);
12. Helium (gas);
13. Hydrogen (gas);
14. Krypton (gas);
15. Methane (liquid and gas);
16. Methanol (liquid and gas);
17. Neon (gas);
18. Nitrogen (liquid and gas);
19. Oxygen (liquid and gas);
20. Propane (liquid and gas);
21. Propylene (gas);
22. R22 (liquid) [3];
23. R123 (liquid) [4];
24. R134a (liquid) [5];
25. RC318 (liquid) [6];
26. Water (liquid);
27. Xenon (gas).

The process of flow of liquids and gases was carried out by the same conditions. Flow direction was constant for liquids and gases. Due to lower density, mass flow rate of gas was reduced in 10 times in comparison with mass flow rate of liquids.

Results and discussion

Comparing of flow parameters of liquids and gases is presented in the summary table 1. Min and max are minimum and maximum values of aerodynamic and hydrodynamic parameters of liquids and gases, respectively.

From considered liquids the highest density has RC318, from gases the highest density has xenon. Density and temperature of liquid are almost not changed when increasing of hydraulic pressure in the conditions of flow. For gases there are characteristically significant increasing of velocity flow, density and temperature when increasing of pressure.

Table 1

Flow parameters of gases and liquids.

Acetone (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/273077.81	293.2/293.22	792.57/792.6	0/0.378	-0.023/0.055
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/56.66	0/4.68×10^{-4}	2160.2/2160.3	0.0003/0.0003	0.005/28.714
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
4.2409535/4.241596	-	0.1615/0.1615	2.8616×10^{-5}/539.1951	0.029/59.089
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV [7]
8×10^{-4}/0.266	6.789×10^{-9}/21.809	1.15×10^{-10}/62.92	293.22/293.22	-1.41/-0.81
Acetone (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/364382.24	287/293.21	2.49/8.77	0/12.446	-0.424/1.487
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/194.01	0/2.03×10^{-4}	1296.9/1886.9	7.237×10^{-6}/7.3954×10^{-6}	0.082/953.962
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.8590031/1.2587339	0/0.06	0.0108/0.0111	2.8616×10^{-6}/39.4804	0.002/6.443
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.212	5.709×10^{-7}/4025.732	8.86×10^{-8}/210586.71	287.26/291.69	-5.59/-0.91
Air (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/456625.1	279.99/293.2	1.29/5.57	0/22.644	-0.467/2.823
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/333.54	0/4.98×10^{-4}	1013.1/2093.3	1.7378×10^{-5}/1.8102×10^{-5}	0.07/1755.568
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.710799/1.4687759	0/0.07	0.0247/0.0254	2.8616×10^{-6}/25.7753	0.002/4.057
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.171	1.44×10^{-6}/8564.652	3.55×10^{-7}/875062.31	280.46/290.85	-9.06/-1.18
Ammonia (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/337636.99	293.2/293.21	609.44/609.45	0/0.492	-0.028/0.07
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/73.63	0/3.99×10^{-4}	4745.6/4745.6	0.0001/0.0001	0.004/37.392
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.3134004/1.3134267	-	0.4997/0.4997	2.8616×10^{-5}/535.5151	0.022/45.436
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	1.148×10^{-8}/36.382	2.53×10^{-10}/135.59	293.2/293.21	-1.55/-0.82
Ammonia (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/555840.42	279.99/293.2	0.77/4.01	0/37.824	-0.769/4.714
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/556.23	0/5.13×10^{-4}	2172.5/4024.4	9.613×10^{-6}/1.0066×10^{-5}	0.006/2963.638
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.9275258/1.7181831	0/0.09	0.0221/0.0231	2.8616×10^{-6}/23.9603	0.001/2.921
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.164	2.778×10^{-6}/17514.341	9.51×10^{-7}/2783322.37	280.37/291.29	-9.38/-1.15
Argon (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/230689.1	293.12/293.2	1164.07/1164.07	0/0.257	-0.014/0.037
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/38.54	0/1.85×10^{-4}	1332.4/1332.4	0.0001/0.0001	5.728×10^{-4}/19.437
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.7436429/1.7436429	-	0.0832/0.0832	2.8616×10^{-5}/532.9398	0.043/86.783
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	3.147×10^{-9}/9.879	3.63×10^{-11}/19.19	293.14/293.16	-1.24/-0.82
Argon (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/424904.75	279.99/293.2	1.75/7.13	0/16.857	-0.429/2.092
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/253.37	0/4.32×10^{-4}	529/1321.7	2.1517×10^{-5}/2.2401×10^{-5}	0.033/1314.836
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s

0.6741774/1.6843888	0/0.06	0.0169/0.0173	2.8616×10^{-6}/31.947	0.002/5.192
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.188	8.794×10^{-7}/5780.122	1.69×10^{-7}/423356.34	280.54/290.76	-8.83/-1.16
Butane (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/366278.5	288.24/293.21	2.48/8.8	0/12.51	-0.434/1.499
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/195.26	$0/2.02\times10^{-4}$	1638.1/2205.3	7.25×10^{-6}/7.3836×10^{-6}	0.079/957.771
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7985167/1.0780602	0/0.06	0.0148/0.0151	2.8616×10^{-6}/40.0093	0.002/6.479
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.213	5.647×10^{-7}/4070.98	8.72×10^{-8}/212874.76	288.45/292.01	-5.11/-0.84
Carbon dioxide (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/410978.05	280.1/293.2	1.91/7.61	0/15.667	-0.471/1.92
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/239.73	$0/3.26\times10^{-4}$	858.9/1601.2	1.3984×10^{-5}/1.4647×10^{-5}	0.052/1222.446
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7032722/1.314071	0/0.06	0.0171/0.0175	2.8616×10^{-6}/35.2204	0.002/5.524
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.198	7.769×10^{-7}/5306.59	1.41×10^{-7}/349105.89	281.19/290.38	-8.22/-1.23
Chlorine (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/330813.8	281.31/293.22	3.02/9.82	0/10.231	-0.447/1.209
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/162.4	$0/2.41\times10^{-4}$	483.1/976	1.2506×10^{-5}/1.3064×10^{-5}	0.07/782.105
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6972721/1.409706	0/0.05	0.0087/0.0088	2.8616×10^{-6}/41.7238	0.003/7.122
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.22	4.673×10^{-7}/3127.628	6.56×10^{-8}/136309.3	282.27/290.28	-7.48/-1.18
Ethane (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/406539.98	293.18/293.2	457.85/457.85	0/0.655	-0.039/0.094
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/98.07	$0/4.1\times10^{-4}$	2921.6/2921.6	8.1812×10^{-5}/8.1812×10^{-5}	0.006/49.632
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
2.1261514/2.1261514	-	0.1124/0.1124	2.8616×10^{-5}/537.1098	0.017/34.134
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	2.034×10^{-8}/64.858	5.96×10^{-10}/322.76	293.18/293.2	-1.70/-0.82
Ethane (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/457975.39	281.01/293.2	1.33/5.79	0/21.941	-0.504/2.754
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/322.33	$0/3.38\times10^{-4}$	1750.6/2874.4	8.7775×10^{-6}/9.125×10^{-6}	0.069/1691.727
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7765416/1.3136242	0/0.07	0.0193/0.02	2.8616×10^{-6}/26.3385	0.002/4.225
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.172	1.328×10^{-6}/8196.684	3.14×10^{-7}/813500.84	281.99/290.95	-8.01/-1.15
Ethanol (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/273119.12	293.2/293.23	790.51/790.53	0/0.379	-0.023/0.055
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/56.8	$0/8.87\times10^{-4}$	2398/2398.3	0.0011/0.0011	0.005/28.694
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
18.119794/18.126087	-	0.1512/0.1512	2.8616×10^{-5}/539.0227	0.029/58.935
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	6.824×10^{-9}/21.909	1.16×10^{-10}/63.36	293.22/293.23	-1.41/-0.81
Ethanol (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/405988.39	285.24/293.2	2/7.8	0/15.249	-0.478/1.862
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/233.72	$0/2.42\times10^{-4}$	1428.8/2189.2	8.2198×10^{-6}/8.4551×10^{-6}	0.067/1192.605
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.8075278/1.2704423	0/0.06	0.0142/0.0146	2.8616×10^{-6}/36.6393	0.002/5.713
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.202	7.263×10^{-7}/5181.581	1.27×10^{-7}/329219.05	285.55/291.31	-6.41/-1.01
Ethylene (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/389794.47	293.16/293.2	481.14/481.14	0/0.623	-0.037/0.09
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s

0/93.31	0/4.12×10^{-4}	2750.3/2750.3	9.1291×10^{-5}/9.1291×10^{-5}	0.007/47.194
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.9205816/1.9205816	-	0.1307/0.1307	2.8616×10^{-5}/537.8207	0.017/35.869
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	1.842×10^{-8}/58.891	5.14×10^{-10}/279.26	293.17/293.19	-1.68/-0.82
Ethylene (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/463688.31	279.99/293.2	1.25/5.49	0/23.333	-0.501/2.904
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/342.98	0/3.78×10^{-4}	1518.6/2647.1	9.7537×10^{-6}/1.0179×10^{-5}	0.086/1800.252
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7791445/1.3581254	0/0.07	0.0184/0.0193	2.8616×10^{-6}/25.6195	0.002/3.993
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.17	1.487×10^{-6}/8933.909	3.72×10^{-7}/939667.93	280.53/290.75	-8.77/-1.21
Fluorine (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/433086.27	279.99/293.2	1.67/6.93	0/17.575	-0.421/2.185
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/262.34	0/4.53×10^{-4}	832.6/1671.5	2.2349×10^{-5}/2.3408×10^{-5}	0.017/1359.94
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7116161/1.4285958	0/0.06	0.0263/0.0269	2.8616×10^{-6}/30.9442	0.002/5.038
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.185	9.339×10^{-7}/6104.408	1.85×10^{-7}/470904.42	280.48/290.45	-8.89/-1.24
Helium (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/803929.48	279.99/293.2	0.22/1.4	0/130.398	-6.932/13.659
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/1871.67	0/2.12×10^{-3}	5028.9/12566.6	1.926×10^{-5}/1.995×10^{-5}	0.22/9090.682
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6572041/1.6421951	0/0.15	0.1477/0.1524	2.8616×10^{-6}/12.4479	8.69×10^{-4}/1.034
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.13	2.218×10^{-5}/102745.56	2.15×10^{-5}/5.94×10^{7}	280.28/292.58	-9.93/-1.11
Hydrogen (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/1091988.06	279.99/293.2	0.12/1.01	0/224.332	-9.791/30.617
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/3117.81	0/2.17×10^{-3}	13111.4/27511.1	8.6119×10^{-6}/8.9414×10^{-6}	1.076/15949.458
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6453035/1.3540073	0/0.2	0.1757/0.1824	2.8616×10^{-6}/14.78	8.097×10^{-4}/0.742
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.138	4.305×10^{-5}/225569.14	5.8×10^{-5}/1.98×10^{8}	280.22/292.78	-10.11/-1.1
Krypton (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/302070.72	279.99/293.23	3.55/10.62	0/8.765	-0.45/1.011
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/141.53	0/3.09×10^{-4}	253.4/635.8	2.3605×10^{-5}/2.4643×10^{-5}	0.058/656.323
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6693651/1.6797399	0/0.05	0.0089/0.0091	2.8616×10^{-6}/43.4197	0.003/7.671
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.228	4.029×10^{-7}/2566.96	5.25×10^{-8}/97108.21	280.67/289.91	-8.3/-1.22
Methane (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/487770.13	293.05/293.2	356.4/356.4	0/0.841	-0.05/0.121
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/125.95	0/4.3×10^{-4}	4077.4/4077.5	5.4455×10^{-5}/5.4455×10^{-5}	0.01/63.659
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.734554/1.734554	-	0.128/0.128	2.8616×10^{-5}/538.3689	0.013/26.57
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	3.358×10^{-8}/107.539	1.26×10^{-9}/689.07	293.07/293.13	-1.88/-0.83
Methane (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/451219.43	279.99/293.2	0.73/3.06	0/39.362	-1.485/4.941
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/570.57	0/7.86×10^{-4}	2215.6/4188.6	1.0486×10^{-5}/1.0915×10^{-5}	0.315/3032.419
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.702232/1.3275826	0/0.09	0.0329/0.0345	5.0779×10^{-9}/17.118	0.006/2.238
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
2.902×10^{-5}/0.138	4.734×10^{-6}/17653.214	2.12×10^{-6}/2862731.13	280.62/293.19	-9.29/-0.59
Methanol (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s

101325/280950.19	293.2/293.23	791.51/791.54	0/0.379	-0.022/0.054
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/56.71	$0/6.16\times10^{-4}$	2505.2/2505.4	0.0006/0.0006	0.003/28.746
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
7.2250349/7.2268248	-	0.1922/0.1922	2.8616×10^{-5}/536.2664	0.029/59.01
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	6.807×10^{-9}/21.638	1.15×10^{-10}/62.2	293.22/293.23	-1.41/-0.81
Methanol (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/445382.05	280.77/293.2	1.41/5.99	0/20.978	-0.506/2.615
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/313.32	$0/3.32\times10^{-4}$	1490/2503.9	9.0676×10^{-6}/9.5031×10^{-6}	0.027/1633.678
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.9670902/1.6768456	0/0.07	0.0136/0.0142	2.8616×10^{-6}/27.7621	0.002/4.368
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.176	1.243×10^{-6}/7693.616	2.84×10^{-7}/711279.11	281.8/290.85	-8.12/-1.17
Neon (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/514882.28	279.99/293.2	0.91/4.37	0/32.475	-0.759/4.031
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/482.51	$0/8.23\times10^{-4}$	1038.9/2599.1	2.9538×10^{-5}/3.0607×10^{-5}	0.035/2542.451
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6643545/1.6620547	0/0.08	0.0461/0.0474	2.8616×10^{-6}/24.6251	0.002/3.198
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.167	2.317×10^{-6}/14131.592	7.25×10^{-7}/1945504.68	280.45/291.56	-9.27/-1.05
Nitrogen (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/309968.11	293.05/293.2	684.47/684.47	0/0.438	-0.025/0.063
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/65.59	$0/2.59\times10^{-4}$	2344.6/2344.7	7.3155×10^{-5}/7.3155×10^{-5}	0.003/33.36
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.7394612/1.7394612	-	0.0986/0.0986	2.8616×10^{-5}/536.0209	0.025/51.028
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	9.103×10^{-9}/28.906	1.78×10^{-10}/96.04	293.07/293.12	-1.53/-0.83
Nitrogen (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/458495.98	279.99/293.2	1.25/5.41	0/23.455	-0.494/2.899
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/346.38	$0/5.05\times10^{-4}$	1047.4/2184.8	1.6824×10^{-5}/1.7454×10^{-5}	0.079/1806.965
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.720611/1.5032227	0/0.07	0.0243/0.025	2.8616×10^{-6}/25.4253	0.002/3.942
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.17	1.526×10^{-6}/8973.901	3.87×10^{-7}/944569.8	280.45/290.9	-9.08/-1.17
Oxygen (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/253489.12	293.14/293.2	951.33/951.33	0/0.315	-0.018/0.045
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/47.16	$0/2.11\times10^{-4}$	1999.4/1999.4	9.4276×10^{-5}/9.4276×10^{-5}	0.002/23.835
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
1.8605807/1.8605807	-	0.1013/0.1013	2.8616×10^{-5}/535.2102	0.035/70.923
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	4.712×10^{-9}/14.914	6.64×10^{-11}/35.59	293.15/293.17	-1.34/-0.82
Oxygen (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/443948.52	279.99/293.2	1.41/5.98	0/20.607	-0.438/2.572
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/304.55	$0/4.85\times10^{-4}$	924.4/1921	1.924×10^{-5}/2.005×10^{-5}	0.042/1599.554
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6934402/1.4410829	0/0.07	0.0256/0.0263	2.8616×10^{-6}/26.8015	0.002/4.355
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.174	1.25×10^{-6}/7508.881	2.87×10^{-7}/699174.33	280.47/290.72	-9/-1.2
Propane (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/372265.02	293.2/293.22	503.35/503.37	0/0.595	-0.036/0.086
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/89.15	$0/4.18\times10^{-4}$	2685.3/2685.5	0.0001/0.0001	0.008/45.084
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
2.8568646/2.8569428	-	0.096/0.096	2.8616×10^{-5}/538.445	0.018/37.527
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	1.683×10^{-8}/53.925	4.49×10^{-10}/244.68	293.21/293.22	-1.64/-0.81

Propane (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/413190.84	285.88/293.2	1.91/7.58	0/15.773	-0.421/1.952
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/238.88	0/2.43×10^{-4}	1620.8/2397.6	7.8284×10^{-6}/8.0081×10^{-6}	0.052/1221.953
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7661103/1.1500248	0/0.06	0.0163/0.0168	2.8616×10^{-6}/33.3446	0.002/5.568
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.192	7.646×10^{-7}/5281.459	1.37×10^{-7}/359686.92	286.15/291.48	-6.18/-0.98
Propylene (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/415431.18	284.72/293.2	1.83/7.3	0/16.369	-0.425/2.023
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/246.63	0/2.58×10^{-4}	1503.1/2303.5	8.1818×10^{-6}/8.4234×10^{-6}	0.036/1273.625
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.7867444/1.2382888	0/0.06	0.0152/0.0157	2.8616×10^{-6}/31.7715	0.002/5.345
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.188	8.298×10^{-7}/5517.442	1.55×10^{-7}/395060.98	285.03/291.24	-6.67/-1.04
R22 (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/216655.08	293.2/293.2	1212.34/1212.36	0/0.247	-0.015/0.035
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/37.03	0/2.26×10^{-4}	1236/1236.1	0.0002/0.0002	0.002/18.83
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
2.50384/2.5038692	-	0.0857/0.0857	2.8616×10^{-5}/537.5019	0.044/90.382
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	2.902×10^{-9}/9.264	3.21×10^{-11}/17.42	293.2/293.2	-1.2/-0.82
R123 (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/196745.96	293.2/293.21	1474.45/1474.48	0/0.203	-0.012/0.029
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/30.45	0/2.96×10^{-4}	1013.6/1013.7	0.0004/0.0004	0.002/15.423
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
5.7649858/5.7655009	-	0.0778/0.0778	2.8616×10^{-5}/536.8061	0.054/109.925
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	1.962×10^{-9}/6.247	1.78×10^{-11}/9.65	293.21/293.21	-1.11/-0.82
R134a (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/219273.67	293.2/293.2	1226.38/1226.4	0/0.244	-0.014/0.035
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/36.59	0/2.43×10^{-4}	1405.2/1405.2	0.0002/0.0002	0.002/18.4
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
3.4989937/3.4990618	-	0.0833/0.0833	2.8616×10^{-5}/535.2238	0.045/91.429
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	2.836×10^{-9}/8.976	3.1×10^{-11}/16.61	293.2/293.2	-1.2/-0.82
RC318 (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/199120.77	293.2/293.2	1517.39/1517.4	0/0.197	-0.011/0.028
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/29.57	0/2.69×10^{-4}	1101.3/1101.3	0.0004/0.0004	8.297×10^{-4}/14.836
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
6.4829169/6.4831606	-	0.0664/0.0664	2.8616×10^{-5}/533.7568	0.056/113.124
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	1.852×10^{-9}/5.832	1.64×10^{-11}/8.7	293.2/293.2	-1.1/-0.82
Water (liquid)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/249149.99	293.2/293.22	997.56/997.56	0/0.3	-0.017/0.043
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/45	0/6.53×10^{-4}	4184.4/4184.4	0.001/0.001	0.001/22.762
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
6.9916411/6.995035	-	0.5985/0.5985	2.8616×10^{-5}/534.1893	0.037/74.37
Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.266	4.286×10^{-9}/13.513	5.76×10^{-11}/30.69	293.21/293.22	-1.29/-0.81
Xenon (gas)				
Pressure, Pa	Temperature, K	Density, kg/m^3	Velocity, m/s	Radial velocity, m/s
101325/244882.88	281.04/293.24	5.51/13.44	0/5.8	-0.348/0.644
Dynamic pressure, Pa	Shear stress, Pa	Specific heat, J/(kg·K)	Dynamic viscosity, Pa·s	Vorticity, 1/s
0/95.92	0/2.37×10^{-4}	162.9/417	2.1641×10^{-5}/2.2512×10^{-5}	0.043/440.707
Prandtl number	Mach number	Fluid thermal conductivity, W/(m·K)	Turbulent viscosity, Pa·s	Turbulent time, s
0.6558653/1.6834597	0/0.04	0.0053/0.0054	2.8616×10^{-6}/44.9239	0.004/9.705

Turbulent length, m	Turbulent energy, J/kg	Turbulent dissipation, W/kg	Operative temperature, K	PMV
8×10^{-4}/0.237	2.516×10^{-7}/1440.015	2.59×10^{-8}/38505.48	282.09/289.79	-7.14/-1.18

Maximum specific heat is observed in gases having low density, such as hydrogen and helium. Specific heat and fluid thermal conductivity of water at room temperature are 4184.4 J/(kg·K) and 0.5985 W/(m·K), respectively. This is the highest values of these parameters for liquids and some gases.

The calculation of the Mach number was carried out only for gases. The Mach number for all gases is 0 at normal atmospheric pressure. The Mach number will be 0.2 when increasing of gas pressure in 10 times. Thermal processes in fluids can be represented by the Prandtl number. Value of the Prandtl number will depend on dynamic viscosity of liquid or gas. In accordance with the results written in the summary table, the highest thermal conductivity have liquids and, in particular, ethanol.

Transient flow of liquids and gases is represented by viscosity, energy, dissipation, and intensity of turbulent flow acted at the some distance for some time. Intensity of vorticity flow of gases prevails over intensity of vorticity flow of liquids. However, turbulent time of gas is less than liquid. Turbulent flow of liquid acts at the larger distance (length of the pipeline) than turbulent flow of gas. Consequently, energy and dissipation of turbulent flow of gas will be more than liquid.

Conclusion

Recommendations for this article will be fair for the straight pipelines of short length. At same mass flow rate it is necessary to increase in several times overall dimensions (diameters and wall thickness) of the pipeline for transportation of different gases. Dimensions of the pipeline it is possible to determine by the calculated values of fluid pressure. Flow of gases is accompanied by the most intensity of vorticity formation acted on the adopted section of the pipeline (on average 0.18 m) not more than 10 s.

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