

Calculation and Sizing of the Aspiration System of the Waste Pre-treatment Filtration System and Activated Carbon Filter, Including Airflow Velocity in the Ductwork

Pressure Drop Calculation

Based on the designed airflow volume and velocity, as well as the geometric characteristics of the ductwork, the total pressure drop in the duct system was calculated. The pressure drop calculation for the dedusting system was performed using a mathematical model via the IPS software. Characteristic calculation formulas are provided in the following text. Table 1 presents the obtained calculation results for the facility that is the subject of this project.

$$\Delta p = \left(L \cdot \frac{\chi}{d} + \sum \zeta \right) \cdot \left(\frac{\rho \cdot v^2}{2} \right)$$

Where:

Δp (Pa) - pressure drop in the duct,

L (m) - duct length,

$\chi = 0,013 + \frac{0,01}{d}$ - friction coefficient,

$d = \sqrt{(4 \cdot Q / 3600 \cdot \pi \cdot v)}$, m - duct diameter,

ρ (kg/m³) - air density,

$\sum \zeta$ - sum of local resistance coefficients (at the duct inlet/outlet, bends, branches, expansions/reductions)

v (m/s) - gas flow velocity in the duct

Table 1.

Section	t (°C)	Q (m³/h)	Du (mm)	a (mm)	b (mm)	Dekv (mm)	l (m)	ρ (kg/m³)	λ	Σξ	v (m/s)	R Ns²/m⁸	Δp (Pa)
1	20	5000	290			290.0	9.2	1.205	0.0164	1.2	21.03	1.83E-05	458.83
2	20	2000	185			185.0	7.6	1.205	0.0184	1.12	20.67	1.21E-04	484.12
3	20	7000	340			340.0	4.3	1.205	0.0159	0.3	21.42	2.83E-06	138.63
4	20	3000	225			225.0	4.9	1.205	0.0174	1.12	20.96	4.41E-05	397.21
5	20	10000	410			410.0	4.5	1.205	0.0154	0.3	21.04	1.25E-06	125.21
6	20	5000	290			290.0	4.4	1.205	0.0164	1.12	21.03	1.46E-05	364.90
7	20	15000	500			500.0	1.0	1.205	0.0150	0.3	21.22	3.98E-07	89.53
8	20	2000	185			185.0	8.6	1.205	0.0184	1.12	20.67	1.27E-04	509.97
9	20	17000	535			535.0	1.5	1.205	0.0149	0.3	21.01	3.14E-07	90.84
10	20	2000	185			185.0	7.6	1.205	0.0184	1.42	20.67	1.40E-04	561.53
11	20	19000	560			560.0	2.7	1.205	0.0148	0.3	21.43	2.85E-07	102.72
12	20	5000	290			290.0	9.9	1.205	0.0164	1.12	21.03	1.79E-05	448.10
13	20	24000	630			630.0	10.4	1.205	0.0146	0.8	21.39	4.98E-07	286.82
14	20	24000	630			630.0	29.2	1.205	0.0146	1.62	21.39	1.10E-06	632.75
15	20	24000	630			630.0	6.7	1.205	0.0146	1.3	21.39	6.96E-07	400.68
16	20	24000	630			630.0	13.1	1.205	0.0146	1.84	21.39	1.03E-06	590.64

17	20	24000	700			700.0	5.2	1.205	0.0144	0.5	17.32	1.91E-07	109.78
18	20	24000	775			775.0	2.5	1.205	0.0143	0.6	14.13	1.35E-07	77.75
19	20	24000	775			775.0	7.6	1.205	0.0143	1.12	14.13	2.63E-07	151.64
20	20	24000		600	600	656.0	1.8	1.205	0.0145	0.3	19.72	1.38E-07	79.67

Calculation and Sizing of the Aspiration System of the Solidification Filtration System, Including Gas Flow Velocity in the Ductwork

Pressure Drop Calculation

Based on the designed air volume and velocity, as well as the geometric characteristics of the ductwork, the total pressure drop in the system was calculated. The pressure drop calculation for the dedusting system was performed using a mathematical model via IPS software. The following section presents the characteristic calculation formulas. Table 2 shows the obtained calculation results for the solidification facility.

$$\Delta p = \left(L \cdot \frac{\chi}{d} + \sum \zeta \right) \cdot \left(\frac{\rho \cdot v^2}{2} \right)$$

Where:

Δp (Pa) - pressure drop in the ductwork,

L (m) - duct length,

$\chi = 0,013 + \frac{0,01}{d}$ - friction coefficient,

$d = \sqrt[3]{(4 \cdot Q / 3600 \cdot \pi \cdot v)}$, m - duct diameter,

ρ (kg/m³) - air density,

$\sum \zeta$ - sum of local resistance coefficients (at the duct inlet/outlet, bends, branches, expansions/reductions)

v (m/s) - gas flow velocity in the ductwork

Table 2.

Section	t (°C)	Q (m³/h)	Du (mm)	a (mm)	b (mm)	Dekv (mm)	l (m)	ρ (kg/m³)	λ	Σξ	v (m/s)	R Ns²/m⁸	Δp (Pa)
1	20	1000		200	1200	490.0	3.3	1.205	0.0150	1	1.47	1.44E-06	1.44
2	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
3	20	2000	210			210.0	2.2	1.205	0.0178	0.3	16.04	1.88E-05	75.38
4	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
5	20	3000	240			240.0	2.2	1.205	0.0172	0.3	18.42	1.04E-05	93.52
6	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
7	20	4000	260			260.0	2.2	1.205	0.0168	0.3	20.93	7.30E-06	116.79
8	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
9	20	5000	300			300.0	2.2	1.205	0.0163	0.3	19.65	3.91E-06	97.65
10	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
11	20	6000	315			315.0	2.2	1.205	0.0162	0.3	21.39	3.16E-06	113.81
12	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
13	20	7000	340			340.0	2.2	1.205	0.0159	0.3	21.42	2.27E-06	111.41
14	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
15	20	8000	360			360.0	2.2	1.205	0.0158	0.3	21.83	1.78E-06	113.84
16	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
17	20	9000	390			390.0	2.2	1.205	0.0156	0.3	20.93	1.26E-06	102.33

18	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
19	20	10000	410			410.0	2.2	1.205	0.0154	0.3	21.04	1.02E-06	102.11
20	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
21	20	11000	430			430.0	2.2	1.205	0.0153	0.3	21.04	8.34E-07	100.94
22	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
23	20	12000	450			450.0	2.2	1.205	0.0152	0.3	20.96	6.88E-07	99.09
24	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
25	20	13000	460			460.0	2.2	1.205	0.0152	0.3	21.73	6.27E-07	105.98
26	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
27	20	14000	480			480.0	2.2	1.205	0.0151	0.3	21.49	5.24E-07	102.72
28	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
29	20	15000	500			500.0	2.2	1.205	0.0150	0.3	21.22	4.41E-07	99.30
30	20	1000		200	1200	490.0	1.1	1.205	0.0150	1	1.47	1.35E-06	1.35
31	20	16000	520			520.0	10.5	1.205	0.0149	0.6	20.93	9.29E-07	237.84
32	20	1500	160			160.0	8.5	1.205	0.0193	1.69	20.72	3.12E-04	706.18
33	20	3500	245			245.0	1.0	1.205	0.0171	0.82	20.62	1.86E-05	228.00
34	20	5000	290			290.0	1.1	1.205	0.0164	0.9	21.03	1.03E-05	256.38
35	20	2000	185			185.0	3.9	1.205	0.0184	1.2	20.67	1.02E-04	409.25
36	20	2000	185			185.0	2.2	1.205	0.0184	1.05	20.67	8.16E-05	326.81
37	20	4000	260			260.0	10.5	1.205	0.0168	1.54	20.93	3.66E-05	586.28

38	20	9000	390			390.0	3.5	1.205	0.0156	0.82	20.93	3.13E-06	253.24
39	20	25000	650			650.0	4.1	1.205	0.0145	0.9	20.93	4.19E-07	261.69
40	20	25000	650			650.0	3.1	1.205	0.0145	0.8	20.93	3.67E-07	229.40
41	20	25000	650			650.0	14.3	1.205	0.0145	1.62	20.93	8.19E-07	511.86
42	20	25000	800			800.0	6.2	1.205	0.0143	0.6	13.82	1.31E-07	81.70
43	20	25000	800			800.0	6.4	1.205	0.0143	0.6	13.82	1.31E-07	82.11

Based on all of the above, the total pressure drop in the ductwork is adopted as:

$$\Delta p = 2329 \text{ Pa}$$