## Calculation formula for heat dissipation of pipes using electric heating cable

1、 Determine the process parameters of the pipe to be traced

Before the installation of electric tracing band, it is necessary to calculate and design the relevant antifreeze and thermal insulation scheme according to the actual situation and requirements of the site. In order to design an accurate scheme correctly, it needs the support of various parameters. Maintenance temperature (Tw) of heat tracing medium, pipe diameter D, surface area s of tank body, insulation material and thickness δ, minimum ambient temperature (Th) of electric tracing zone using area, installation environment (such as buried pipe, indoor or outdoor, etc.). The difference between the temperature to be maintained (TW) of the medium in the pipeline and the lowest ambient temperature (Th) in the service area of the tracing zone is calculated, which is expressed by $\triangle$ T, and the formula is: $\triangle$ t = Tw-Th.

2、 Calculation of heat dissipation of heat tracing pipe

Calculation formula of pipe heat dissipation: q = q × f × e × H

Q: refers to the heat tracing required by the pipeline

Q: refers to the heat dissipation capacity of the pipeline in the benchmark unit (according to the thickness of insulation material, temperature difference, pipeline size and other parameters, refer to Table 1-1 below)

F: correction coefficient of thermal insulation material (refer to table 1-2 below)

E: the correction factor of pipeline material (refer to table 1-3 below)

H: the correction coefficient of environmental conditions (see table 1-4 below)

3、 Example of heat tracing calculation of pipeline:

The chemical medium transportation (stainless steel) pipe has a diameter of 4 ", the thickness of the outer thermal insulation layer of polyurethane foam plastic is 20mm, the chemical medium in the pipeline needs to maintain the temperature of 15 degrees, the minimum temperature in winter is -25 degrees, and the outdoor ambient wind speed is 15m/s, and the heat loss per meter pipe is calculated.

$\triangle$T=Tw-TH=15℃-（-25℃）=40℃

Refer to the following Table 1-1: the pipe diameter (d) is 4 ", the thickness of the external insulation layer is 20 mm, the temperature difference $\triangle$ t = 40 °C, and q = 33 w / m

Check table 1-2: the insulation layer is made of polyurethane foam, and its thermal insulation coefficient is f=0.67

Refer to the following table 1-3: the correction coefficient for the average wind speed of 15m / s in the outdoor environment is: H = 1.15

By substituting the above parameters into the formula (q = q × f × e × h): q = 33 × 0.67 × 0.9 × 1.15, the heat tracing required by the heat tracing pipe is calculated as: q = 22.88w/m.

4，Check the table of parameters (1-1, 2, 3, 4)

表1-1 Pipe heat dissipation (q)

| Insulation thickness (mm) | ΔT (℃) | Pipe inner diameter (mm / feet) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15 | 25 | 40 | 50 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 |
| | | 1/2" | 1" | 1.5" | 2" | 3" | 4" | 6" | 8" | 10" | 12" | 14" | 16" | 18" | 20" | 24" |
| 10 | 20 | 7.2 | 10.1 | 13.6 | 16.4 | 23.0 | 28.8 | 41.1 | 52.6 | 64.7 | 76.1 | 83.3 | 94.6 | 105.9 | 117.2 | 139.7 |
| | 30 | 11.0 | 15.4 | 20.7 | 24.9 | 35.0 | 43.8 | 62.5 | 80.0 | 98.5 | 115.8 | 126.7 | 143.9 | 161.1 | 178.3 | 212.6 |
| | 40 | 14.9 | 20.8 | 27.9 | 33.7 | 47.3 | 59.2 | 84.5 | 108.2 | 133.2 | 156.6 | 171.3 | 194.6 | 217.5 | 241.1 | 287.4 |
| 20 | 20 | 4.6 | 6.2 | 8.0 | 9.5 | 13.0 | 16.0 | 22.5 | 28.5 | 34.9 | 40.9 | 44.7 | 50.7 | 56.7 | 62.6 | 74.6 |
| | 30 | 7.0 | 9.4 | 12.2 | 14.5 | 19.8 | 24.4 | 34.3 | 43.4 | 52.2 | 62.3 | 68.0 | 477.1 | 86.2 | 95.3 | 113.4 |
| | 40 | 9.5 | 12.7 | 16.5 | 19.6 | 26.7 | 33.0 | 46.3 | 58.7 | 71.9 | 84.2 | 92.0 | 104.3 | 116.6 | 128.9 | 153.4 |
| | 60 | 14.7 | 19.6 | 25.5 | 30.2 | 41.2 | 50.9 | 71.4 | 90.5 | 110.8 | 129.9 | 141.8 | 160.8 | 179.7 | 198.7 | 236.6 |
| 25 | 20 | 4.1 | 5.3 | 6.9 | 8.1 | 10.9 | 13.4 | 18.6 | 23.5 | 28.7 | 33.5 | 36.5 | 41.4 | 46.2 | 51.1 | 60.7 |
| | 30 | 6.2 | 8.1 | 10.4 | 12.3 | 16.6 | 20.3 | 28.3 | 35.7 | 43.6 | 51.0 | 55.6 | 63.0 | 70.3 | 77.7 | 92.4 |
| | 40 | 8.4 | 11.0 | 14.1 | 16.6 | 22.4 | 27.5 | 38.2 | 48.3 | 59.0 | 69.0 | 75.2 | 85.2 | 95.1 | 105.1 | 124.9 |
| | 60 | 12.9 | 17.0 | 21.8 | 25.6 | 34.5 | 42.4 | 59.0 | 74.5 | 90.9 | 106.3 | 115.9 | 131.3 | 146.7 | 162.0 | 192.6 |
| | 80 | 17.7 | 23.3 | 29.9 | 35.1 | 47.4 | 58.2 | 81.0 | 102.3 | 124.8 | 146.0 | 159.2 | 180.3 | 201.4 | 222.4 | 264.5 |
| | 100 | 25.8 | 30.1 | 38.6 | 45.4 | 61.2 | 75.2 | 104.5 | 132.0 | 161.1 | 188.5 | 205.5 | 232.8 | 260.0 | 287.2 | 31.5 |
| 30 | 20 | 3.7 | 4.8 | 6.1 | 7.1 | 9.5 | 11.6 | 15.9 | 20.0 | 24.4 | 28.5 | 31.0 | 35.1 | 39.2 | 43.2 | 51.3 |
| | 30 | 5.6 | 7.3 | 9.2 | 10.8 | 14.4 | 17.6 | 24.3 | 30.5 | 37.1 | 43.3 | 47.2 | 53.4 | 59.6 | 65.8 | 78.1 |
| | 40 | 7.6 | 9.8 | 12.5 | 14.6 | 19.5 | 23.8 | 32.8 | 41.3 | 50.2 | 58.6 | 63.8 | 72.2 | 80.6 | 88.9 | 105.6 |
| | 60 | 11.7 | 15.1 | 19.2 | 22.5 | 30.0 | 36.6 | 50.6 | 63.6 | 77.4 | 90.4 | 98.4 | 111.4 | 124.3 | 137.1 | 162.9 |
| | 80 | 16.0 | 20.8 | 26.4 | 30.9 | 41.2 | 50.3 | 69.4 | 87.3 | 106.3 | 124.0 | 135.1 | 152.9 | 170.6 | 188.3 | 223.6 |
| | 100 | 20.7 | 26.8 | 34.1 | 39.8 | 53.2 | 65.0 | 89.7 | 112.8 | 137.2 | 160.2 | 174.5 | 197.4 | 220.3 | 243.1 | 288.7 |
| | 120 | 25.6 | 33.2 | 42.2 | 49.3 | 65.9 | 80.4 | 111.0 | 139.6 | 169.9 | 198.3 | 216.1 | 244.4 | 272.8 | 301.0 | 357.5 |
| | 140 | 30.8 | 40.0 | 50.8 | 59.4 | 793 | 96.8 | 133.5 | 168.0 | 204.4 | 238.6 | 259.9 | 294.0 | 328.1 | 361.1 | 430.1 |
| | 160 | 35.2 | 41.7 | 59.8 | 69.9 | 93.3 | 113.9 | 157.2 | 197.7 | 240.6 | 280.8 | 306.0 | 346.1 | 386.2 | 426.3 | 506.2 |
| | 180 | 42.0 | 54.5 | 69.2 | 80.9 | 108.1 | 131.9 | 182.0 | 228.9 | 278.6 | 325.2 | 354.2 | 400.7 | 447.1 | 493.5 | 586.2 |
| 40 | 20 | 3.2 | 4.0 | 5.0 | 5.8 | 7.6 | 9.2 | 12.6 | 15.7 | 19.0 | 22.1 | 24.0 | 27.4 | 30.2 | 33.0 | 39.4 |
| | 30 | 4.8 | 6.1 | 7.7 | 8.9 | 11.6 | 14.1 | 19.1 | 23.9 | 28.9 | 33.6 | 36.6 | 41.3 | 45.9 | 50.6 | 60.0 |
| | 40 | 6.5 | 8.3 | 10.4 | 12.0 | 15.7 | 19.0 | 25.9 | 32.3 | 39.1 | 45.5 | 49.4 | 55.8 | 62.1 | 68.5 | 81.1 |
| | 60 | 10.1 | 12.8 | 16.0 | 18.5 | 24.3 | 29.3 | 39.9 | 49.8 | 60.3 | 70.1 | 76.2 | 86.0 | 95.8 | 105.6 | 125.1 |
| | 80 | 13.8 | 17.6 | 21.9 | 25.4 | 33.3 | 40.2 | 54.8 | 68.4 | 82.7 | 96.2 | 104.6 | 118.1 | 131.5 | 144.9 | 171.7 |
| | 100 | 17.8 | 22.7 | 28.3 | 32.8 | 43.0 | 52.0 | 70.8 | 88.3 | 106.8 | 124.2 | 135.1 | 152.4 | 169.8 | 187.1 | 221.7 |
| | 120 | 22.1 | 28.1 | 35.1 | 40.6 | 53.3 | 64.4 | 87.6 | 109.3 | 132.3 | 153.9 | 167.3 | 188.8 | 210.3 | 231.7 | 274.5 |
| | 140 | 26.5 | 33.8 | 42.2 | 48.8 | 64.1 | 77.4 | 105.4 | 131.5 | 159.1 | 185.1 | 201.2 | 227.1 | 252.9 | 278.7 | 330.2 |
| | 160 | 31.2 | 39.8 | 49.7 | 57.4 | 75.4 | 91.1 | 124.1 | 154.8 | 187.3 | 217.9 | 236.9 | 267.3 | 297.7 | 328.1 | 388.7 |
| | 180 | 36.2 | 46.0 | 57.5 | 66.5 | 87.3 | 105.5 | 143.7 | 179.3 | 216.9 | 252.2 | 274.3 | 309.5 | 344.7 | 379.9 | 450.1 |
| 50 | 20 | 2.8 | 3.6 | 4.4 | 5.0 | 6.5 | 7.8 | 10.5 | 13.1 | 15.7 | 18.2 | 19.8 | 22.3 | 24.7 | 27.2 | 32.2 |
| | 30 | 4.3 | 5.4 | 6.7 | 7.7 | 9.9 | 11.9 | 16.0 | 19.9 | 23.9 | 27.7 | 30.1 | 33.9 | 37.6 | 41.4 | 48.5 |
| | 40 | 5.8 | 7.3 | 9.1 | 10.4 | 13.4 | 16.1 | 21.7 | 26.9 | 32.3 | 37.5 | 40.7 | 45.8 | 50.9 | 56.0 | 66.2 |
| | 60 | 9.0 | 11.3 | 14.0 | 16.0 | 20.7 | 24.8 | 33.4 | 41.4 | 49.9 | 57.8 | 62.7 | 70.6 | 78.5 | 86.3 | 102.1 |
| | 80 | 12.4 | 15.5 | 19.1 | 22.0 | 28.5 | 34.1 | 45.9 | 56.8 | 68.4 | 79.3 | 86.1 | 96.9 | 107.7 | 118.5 | 140.1 |
| | 100 | 16.0 | 20.1 | 24.7 | 28.4 | 36.7 | 44.0 | 59.2 | 73.4 | 88.3 | 102.4 | 111.1 | 125.1 | 139.1 | 153.0 | 180.9 |
| | 120 | 19.8 | 24.8 | 30.6 | 35.1 | 45.5 | 54.4 | 73.3 | 90.9 | 109.4 | 126.8 | 137.6 | 154.9 | 172.7 | 189.5 | 224.0 |
| | 140 | 23.8 | 29.9 | 36.8 | 42.3 | 54.7 | 65.6 | 88.2 | 109.3 | 131.6 | 152.5 | 165.5 | 186.4 | 207.2 | 227.9 | 269.4 |
| | 160 | 28.2 | 35.2 | 43.4 | 49.8 | 64.4 | 77.2 | 103.9 | 128.7 | 154.9 | 179.5 | 194.9 | 219.4 | 243.9 | 268.3 | 317.2 |
| | 180 | 32.5 | 40.7 | 50.2 | 57.6 | 74.6 | 89.4 | 120.3 | 149.0 | 179.4 | 207.9 | 225.6 | 254.0 | 282.4 | 310.7 | 367.2 |
| 80 | 20 | 2.3 | 2.8 | 3.4 | 3.8 | 4.8 | 5.7 | 7.4 | 9.0 | 10.7 | 12.3 | 13.3 | 14.9 | 16.4 | 18.0 | 21.1 |
| | 30 | 3.5 | 4.3 | 5.2 | 5.8 | 7.3 | 8.6 | 11.3 | 13.7 | 16.3 | 18.7 | 20.2 | 22.6 | 25.0 | 27.4 | 32.1 |
| | 40 | 4.8 | 5.8 | 7.0 | 7.9 | 9.9 | 11.6 | 15.2 | 18.5 | 22.0 | 25.3 | 27.3 | 30.6 | 33.8 | 37.0 | 43.5 |
| | 60 | 7.4 | 9.0 | 10.8 | 12.1 | 15.3 | 17.9 | 23.5 | 28.6 | 34.0 | 39.0 | 42.1 | 47.1 | 52.1 | 57.1 | 67.0 |
| | 80 | 10.1 | 12.3 | 14.8 | 16.6 | 20.9 | 24.6 | 32.2 | 39.2 | 46.6 | 53.5 | 54.8 | 64.7 | 71.5 | 78.3 | 92.0 |
| | 100 | 13.0 | 15.9 | 19.1 | 21.5 | 27.0 | 31.8 | 41.6 | 50.6 | 60.2 | 69.1 | 74.6 | 83.5 | 92.3 | 101.2 | 118.8 |
| | 120 | 16.1 | 19.7 | 23.6 | 26.6 | 33.5 | 39.3 | 51.1 | 62.7 | 74.5 | 85.5 | 92.4 | 103.4 | 114.3 | 125.3 | 147.1 |
| | 140 | 19.4 | 23.6 | 28.4 | 32.0 | 40.3 | 47.3 | 62.9 | 75.4 | 89.6 | 102.9 | 111.2 | 124.4 | 137.5 | 150.7 | 176.9 |
| | 160 | 22.9 | 27.8 | 33.4 | 37.7 | 47.4 | 55.7 | 72.9 | 88.8 | 105.5 | 121.1 | 130.9 | 146.4 | 161.9 | 177.4 | 208.3 |
| | 180 | 26.5 | 32.2 | 38.7 | 43.7 | 54.9 | 64.5 | 84.4 | 102.8 | 122.2 | 140.3 | 151.5 | 169.5 | 187.5 | 205.4 | 241.2 |

Table1-2: Insulation material correction factor

| Insulation Materials | Insulation coefficient | Thermal conductivity (w/m.°c) |
|---|---|---|
| glass fiber | 1 | 0.036 |
| Rock wool | 1.22 | 0.044 |
| Slag wool | 1.11 | 0.04 |
| Pearl cotton | 1.31 | 0.047 |
| Polyurethane foam | 0.67 | 0.024 |
| Styrofoam | 0.86 | 0.031 |
| Calcium carbonate | 1.5 | 0.054 |
| Asbestos calcium | 1.83 | 0.066 |
| Composite silicate felt | 0.65 | 0.0234 |

Table1-3: Insulation material correction factor    Table1-4: Environmental condition correction factor

| Pipe material | Correction factor |
|---|---|
| Carbon steel | 1 |
| copper | 1.05 |
| stainless steel | 0.9 |
| plastic | 0.65 |

| Environmental conditions | Correction factor |
|---|---|
| indoor | 1 |
| Outdoor wind speed 5m/s | 1.05 |
| Outdoor wind speed 15m/s | 1.15 |
| Outdoor wind speed 25m/s | 1.3 |