EXPORT GasDiameter(L9,Q9,ε,λ,μ,k,P19,P29,Zm,Tm9,n,Ca,h)

BEGIN

LOCAL Rg,Pm,ρs,C2,D,V2,f1a,f2a;

LOCAL R1,f1,C2a,Da,V2a,R2,f4a,f5a;

LOCAL f2,C2b,Db,V2b,Ma1,D4,f6a,f7a;

LOCAL V4,R4,f4,Ma4,D5,V5,f8a,f10a;

LOCAL R5,f5,Ma5,D6,V6,R6,f11,Ve;

LOCAL f6,Ma6,D7,V7,R7,Vm;

LOCAL f7,Ma7,D8,V8,R8,f8;

LOCAL Ma8,D9,V9,R9,f9,Ma9,ft9;

LOCAL C2c,D10,V10,R10,f10,C2d;

LOCAL Da1,Va1,Ra1,Maa,C2e,Db1;

LOCAL Vb,Rb,ftb,fb,Mab,L,Q,P1;

LOCAL P2,Tm;

PRINT();

L:=L9\*1000;

Q:=Q9/86400;

P1:=P19\*100ᴇ3;

P2:=P29\*100ᴇ3;

Tm:=Tm9+273.15;

CASE

IF L<10ᴇ3 THEN

PRINT(" The length of the duct must be ≥ 10\_km");

BREAK;

END;

IF L>350ᴇ3 THEN

PRINT(" The length of the duct must be ≤ 350\_km");

BREAK;

END;

IF Q<0.5 THEN

PRINT(" The standard flow must be > 0.5\_m^3/s");

BREAK;

END;

IF ε<0 THEN

PRINT(" The absolute roughness must be ≥ 0\_mm");

BREAK;

END;

IF ε>3 THEN

PRINT(" The absolute roughness must be ≤ 3\_mm");

BREAK;

END;

IF λ≤0 THEN

PRINT(" The density must be > 0");

BREAK;

END;

IF λ>0.85 THEN

PRINT(" The density must be ≤ 0.85");

BREAK;

END;

IF μ≤0 THEN

PRINT(" The dynamic viscosity must be > 0\_Pa\*s");

BREAK;

END;

IF μ>1ᴇ−4 THEN

PRINT(" The dynamic viscosity must be ≤ 1ᴇ−4\_Pa\*s");

BREAK;

END;

IF k<1.05 THEN

PRINT(" The isentropic coeff. must be ≥ 1.05");

BREAK;

END;

IF k>1.8 THEN

PRINT(" The isentropic coeff. must be ≤ 1.8");

BREAK;

END;

IF P1>20.9ᴇ6 THEN

PRINT(" P₁ must be ≤ 20.9\_MPa");

BREAK;

END;

IF P1<0.5ᴇ6 THEN

PRINT(" P₁ must be ≥ 0.5\_MPa");

BREAK;

END;

IF P2>P1 THEN

PRINT(" P₂ must be < P₁");

BREAK;

END;

IF P2≤0 THEN

PRINT(" P₂ must be > 0\_MPa");

BREAK;

END;

IF Zm<0.7 THEN

PRINT(" The coeff. compressibility must be ≥ 0.7");

BREAK;

END;

IF Zm≥1 THEN

PRINT(" The coeff. compressibility must be < 1");

BREAK;

END;

IF Tm<243.15 THEN

PRINT(" The average temperature must be ≥ 243.15\_K");

BREAK;

END;

IF Tm>393.15 THEN

PRINT(" The average temperature must be ≤ 393.15\_K");

BREAK;

END;

IF n≤0.80 THEN

PRINT(" The duct efficiency must be > 0.8");

BREAK;

END;

IF n>1 THEN

PRINT(" The duct efficiency must be ≤ 1");

BREAK;

END;

IF Ca≤0.9 THEN

PRINT(" The coefficient for AGA-A must be > 0.9");

BREAK;

END;

IF Ca≥1 THEN

PRINT(" The coefficient for AGA-A must be < 1");

BREAK;

END;

IF h>2ᴇ3 THEN

PRINT(" The height difference (h) must be ≤ 2ᴇ3\_m");

BREAK;

END;

IF h<-1ᴇ3 THEN

PRINT(" The height difference (h) must be < -1ᴇ3\_m");

BREAK;

END;

DEFAULT

END;

///////////////initial clauses (end);

Rg:=287/λ;

Pm:=(2/3)\*((-P1\*P2/(P1+P2))+P1+P2);

ρs:=1.2043\*λ;

///////////////THEORIC;

C2:=1/√0.02;

D:=(2.5) NTHROOT (Q/(13.305\*C2\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

V2:=101325\*Q\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R1:=4\*ρs\*Q/(π\*μ\*D);

CASE

IF ε/(D\*1ᴇ3/2)≤2ᴇ−8 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very smooth tube");

BREAK;

END;

IF ε/(D\*1ᴇ3/2)≥0.1 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very rough tube");

BREAK;

END;

IF R1<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R1>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R1<1ᴇ8 THEN

f1:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R1\*sqrt(f1))))))^2,f1,0.03,10);

END;

DEFAULT

END;

C2a:=1/√f1;

Da:=(2.5) NTHROOT (Q/(13.305\*C2a\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

V2a:=101325\*Q\*Tm\*Zm/((π\*Da^2/4)\*P2\*293.15\*1);

R2:=4\*ρs\*Q/(π\*μ\*Da);

CASE

IF ε/(Da\*1ᴇ3/2)≤2ᴇ−8 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very smooth tube");

BREAK;

END;

IF ε/(Da\*1ᴇ3/2)≥0.1 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very rough tube");

BREAK;

END;

IF R2<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R2>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R2<1ᴇ8 THEN

f2:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*Da))+(2.51/(R2\*sqrt(f2))))))^2,f2,0.03,10);

END;

DEFAULT

END;

C2b:=1/√f2;

Db:=(2.5) NTHROOT (Q/(13.305\*C2b\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

IF Db>0.889 THEN

PRINT(" Review input data");

PRINT(" Maximum diameter reached (35\_in)");

BREAK;

END;

V2b:=101325\*Q\*Tm\*Zm/((π\*Db^2/4)\*P2\*293.15\*1);

Ma1:=V2b/√(k\*Rg\*Tm);

///////////////WEIMOUTH;

D4:=(2.6667) NTHROOT (Q/(137.32\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

V4:=101325\*Q\*Tm\*Zm/((π\*D4^2/4)\*P2\*293.15\*1);

R4:=4\*ρs\*Q/(π\*μ\*D4);

CASE

IF R4<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R4>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R4<1ᴇ8 THEN

f4:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D4))+(2.51/(R4\*sqrt(f4))))))^2,f4,0.03,10);

END;

DEFAULT

END;

Ma4:=V4/√(k\*Rg\*Tm);

///////////////PANHANDLE-A;

D5:=(2.6182) NTHROOT (Q/(99.51\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.8539\*Tm\*Zm))^0.5394/101325));

V5:=101325\*Q\*Tm\*Zm/((π\*D5^2/4)\*P2\*293.15\*1);

R5:=4\*ρs\*Q/(π\*μ\*D5);

CASE

IF R5<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R5>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R5<1ᴇ8 THEN

f5:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D5))+(2.51/(R5\*sqrt(f5))))))^2,f5,0.03,10);

END;

DEFAULT

END;

Ma5:=V5/√(k\*Rg\*Tm);

///////////////PANHANDLE-B;

D6:=(2.53) NTHROOT (Q/(137.24\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.9608\*Tm\*Zm))^0.51/101325));

V6:=101325\*Q\*Tm\*Zm/((π\*D6^2/4)\*P2\*293.15\*1);

R6:=4\*ρs\*Q/(π\*μ\*D6);

CASE

IF R6<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R6>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R6<1ᴇ8 THEN

f6:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D6))+(2.51/(R6\*sqrt(f6))))))^2,f6,0.03,10);

END;

DEFAULT

END;

Ma6:=V6/√(k\*Rg\*Tm);

///////////////IGT;

D7:=(2.6667) NTHROOT (Q/(88.06\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.8\*Tm\*Zm))^0.5555/101325));

V7:=101325\*Q\*Tm\*Zm/((π\*D7^2/4)\*P2\*293.15\*1);

R7:=4\*ρs\*Q/(π\*μ\*D7);

CASE

IF R7<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R7>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R7<1ᴇ8 THEN

f7:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D7))+(2.51/(R7\*sqrt(f7))))))^2,f7,0.03,10);

END;

DEFAULT

END;

Ma7:=V7/√(k\*Rg\*Tm);

///////////////MUELLER;

D8:=(2.724) NTHROOT (Q/(87.51\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.74\*Tm\*Zm))^0.5747/101325));

V8:=101325\*Q\*Tm\*Zm/((π\*D8^2/4)\*P2\*293.15\*1);

R8:=4\*ρs\*Q/(π\*μ\*D8);

CASE

IF R8<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R8>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R8<1ᴇ8 THEN

f8:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D8))+(2.51/(R8\*sqrt(f8))))))^2,f8,0.03,10);

END;

DEFAULT

END;

Ma8:=V8/√(k\*Rg\*Tm);

///////////////FTITZSCHE;

D9:=(2.6911) NTHROOT (Q/(94.26\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.858\*Tm\*Zm))^0.5382/101325));

V9:=101325\*Q\*Tm\*Zm/((π\*D9^2/4)\*P2\*293.15\*1);

R9:=4\*ρs\*Q/(π\*μ\*D9);

CASE

IF R9<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R9>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R9<1ᴇ8 THEN

f9:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D9))+(2.51/(R9\*sqrt(f9))))))^2,f9,0.03,10);

END;

DEFAULT

END;

Ma9:=V9/√(k\*Rg\*Tm);

///////////////AGA-A;

C2c:=2\*Ca\*LOG((R2\*√f2)/2.51);

D10:=(2.5) NTHROOT (Q/(13.303\*C2c\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

V10:=101325\*Q\*Tm\*Zm/((π\*D10^2/4)\*P2\*293.15\*1);

R10:=4\*ρs\*Q/(π\*μ\*D10);

CASE

IF R10<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R10>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R10<1ᴇ8 THEN

f10:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D10))+(2.51/(R10\*sqrt(f10))))))^2,f10,0.03,10);

END;

DEFAULT

END;

C2d:=2\*Ca\*LOG((R10\*√f10)/2.51);

Da1:=(2.5) NTHROOT (Q/(13.303\*C2d\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

Va1:=101325\*Q\*Tm\*Zm/((π\*Da1^2/4)\*P2\*293.15\*1);

Ra1:=4\*ρs\*Q/(π\*μ\*Da1);

Maa:=Va1/√(k\*Rg\*Tm);

///////////////AGA-B;

C2e:=2\*LOG(3.7\*D/(ε\*1ᴇ−3));

Db1:=(2.5) NTHROOT (Q/(13.303\*C2e\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^1\*Tm\*Zm))^0.5/101325));

Vb:=101325\*Q\*Tm\*Zm/((π\*Db1^2/4)\*P2\*293.15\*1);

Rb:=4\*ρs\*Q/(π\*μ\*Db1);

CASE

IF Rb<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF Rb>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<Rb<1ᴇ8 THEN

fb:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*Db1))+(2.51/(Rb\*sqrt(fb))))))^2,fb,0.03,10);

END;

DEFAULT

END;

Mab:=Vb/√(k\*Rg\*Tm);

///////////////EROSION SPEED;

Ve:=120/√(P2/(Zm\*Rg\*Tm));

Vm:=0.5\*Ve;

///////////////plot;

PRINT(" Ⅰ) THEORIC");

PRINT(" f = "+STRING(f2,3,4));

PRINT(" Re = "+STRING(R2,3,2));

PRINT(" Ma = "+STRING(Ma1,2,3));

PRINT(" V = "+STRING(V2b\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(Db\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅱ) WEIMOUTH");

PRINT(" f = "+STRING(f4,3,4));

PRINT(" Re = "+STRING(R4,3,2));

PRINT(" Ma = "+STRING(Ma4,2,3));

PRINT(" V = "+STRING(V4\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D4\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅲ) PANHANDLE-A");

PRINT(" f = "+STRING(f5,3,4));

PRINT(" Re = "+STRING(R5,3,2));

PRINT(" Ma = "+STRING(Ma5,2,3));

PRINT(" V = "+STRING(V5\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D5\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅳ) PANHANDLE-B");

PRINT(" f = "+STRING(f6,3,4));

PRINT(" Re = "+STRING(R6,3,2));

PRINT(" Ma = "+STRING(Ma6,2,3));

PRINT(" V = "+STRING(V6\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D6\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅴ) IGT");

PRINT(" f = "+STRING(f7,3,4));

PRINT(" Re = "+STRING(R7,3,2));

PRINT(" Ma = "+STRING(Ma7,2,3));

PRINT(" V = "+STRING(V7\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D7\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅵ) MUELLER");

PRINT(" f = "+STRING(f8,3,4));

PRINT(" Re = "+STRING(R8,3,2));

PRINT(" Ma = "+STRING(Ma8,2,3));

PRINT(" V = "+STRING(V8\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D8\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅶ) FTITZSCHE");

PRINT(" f = "+STRING(f9,3,4));

PRINT(" Re = "+STRING(R9,3,2));

PRINT(" Ma = "+STRING(Ma9,2,3));

PRINT(" V = "+STRING(V9\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(D9\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅷ) AGA-A");

PRINT(" f = "+STRING(f10,3,4));

PRINT(" Re = "+STRING(Ra1,3,2));

PRINT(" Ma = "+STRING(Maa,2,3));

PRINT(" V = "+STRING(Va1\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(Da1\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" Ⅸ) AGA-B");

PRINT(" f = "+STRING(fb,3,4));

PRINT(" Re = "+STRING(Rb,3,2));

PRINT(" Ma = "+STRING(Mab,2,3));

PRINT(" V = "+STRING(Vb\*1\_(m/s),2,1));

PRINT(" ID = "+STRING(Db1\*39.37\_(in),2,2));

PRINT(" ");

PRINT(" EROSION & DUCT PRESSURE GRADIENT:");

IF V2b≥20 THEN

PRINT(" Not Recommended Speeds");

ELSE

PRINT(" Erosion Velocity ≅ "+STRING(Ve\*1\_(m/s),2,1));

PRINT(" Recommended Max. ≅ "+STRING(Vm\*1\_(m/s),2,1));

END;

PRINT(" Ideal ΔP/L = 10 < ΔP/L < 25\_kPa/km");

PRINT(" Gas Pipeline ΔP/L = "+STRING(((P1-P2)/L)\*1\_(kPa/km),2,1));

END;

//////////////////////////////////////;

EXPORT GasFlowRate(L9,D,ε,λ,μ,k,P19,P29,Zm,Tm9,n,Ca,h)

BEGIN

LOCAL Rg,Pm,f,C2,Q,V2,ρs,R1;

LOCAL f1,C2a,Q1,V2a,R2,f2,C2b,Q2;

LOCAL V2b,R3,f3,Ma1,Q4,V4,R4,f4;

LOCAL Ma4,Q5,V5,R5,f5,Ma5,Q6,V6;

LOCAL R6,f6,Ma6,Q7,V7,R7,f7,Ma7;

LOCAL Q8,V8,R8,f8,Ma8,Q9,V9,R9;

LOCAL f9,Ma9,C2c,Qa,Va,Ra,fa,Maa;

LOCAL C2d,Qa1,Va1,Ra1,C2e,Qb,Vb,f1a;

LOCAL Rb,fb,Mab,Ve,Vm,f2a,f3a,f4a;

LOCAL f5a,f6a,f7a,f8a,f9a,f10a,f11a,L;

LOCAL P1,P2,Tm;

PRINT();

L:=L9\*1000;

P1:=P19\*100ᴇ3;

P2:=P29\*100ᴇ3;

Tm:=Tm9+273.15;

////////////////////initial clauses (start);

CASE

IF L<10ᴇ3 THEN

PRINT(" The length of the duct must be ≥ 10\_km");

BREAK;

END;

IF L>350ᴇ3 THEN

PRINT(" The length of the duct must be ≤ 350\_km");

BREAK;

END;

IF D<0.1016 THEN

PRINT(" The minimum diameter must be ≥ 0.1016\_m");

BREAK;

END;

IF D>0.8001 THEN

PRINT(" The maximum diameter must be ≤ 0.8001\_m");

BREAK;

END;

IF ε<0 THEN

PRINT(" The absolute roughness must be ≥ 0\_mm");

BREAK;

END;

IF ε>3 THEN

PRINT(" The absolute roughness must be ≤ 3\_mm");

BREAK;

END;

IF λ≤0 THEN

PRINT(" The density must be > 0");

BREAK;

END;

IF λ>0.85 THEN

PRINT(" The density must be ≤ 0.85");

BREAK;

END;

IF μ≤0 THEN

PRINT(" The dynamic viscosity must be > 0\_Pa\*s");

BREAK;

END;

IF μ>1ᴇ−4 THEN

PRINT(" The dynamic viscosity must be ≤ 1ᴇ−4\_Pa\*s");

BREAK;

END;

IF k<1.05 THEN

PRINT(" The isentropic coeff. must be ≥ 1.05");

BREAK;

END;

IF k>1.8 THEN

PRINT(" The isentropic coeff. must be ≤ 1.8");

BREAK;

END;

IF P1>20.9ᴇ6 THEN

PRINT(" P₁ must be ≤ 20.9\_MPa");

BREAK;

END;

IF P1<0.5ᴇ6 THEN

PRINT(" P₁ must be ≥ 0.5\_MPa");

BREAK;

END;

IF P2>P1 THEN

PRINT(" P₂ must be < P₁");

BREAK;

END;

IF P2≤0 THEN

PRINT(" P₂ must be > 0\_MPa");

BREAK;

END;

IF Zm<0.7 THEN

PRINT(" The coeff. compressibility must be ≥ 0.7");

BREAK;

END;

IF Zm≥1 THEN

PRINT(" The coeff. compressibility must be < 1");

BREAK;

END;

IF Tm<243.15 THEN

PRINT(" The average temperature must be ≥ 243.15\_K");

BREAK;

END;

IF Tm>393.15 THEN

PRINT(" The average temperature must be ≤ 393.15\_K");

BREAK;

END;

IF n≤0.80 THEN

PRINT(" The duct efficiency must be > 0.8");

BREAK;

END;

IF n>1 THEN

PRINT(" The duct efficiency must be ≤ 1");

BREAK;

END;

IF Ca≤0.9 THEN

PRINT(" The coefficient for AGA-A must be > 0.9");

BREAK;

END;

IF Ca≥1 THEN

PRINT(" The coefficient for AGA-A must be < 1");

BREAK;

END;

IF h>2ᴇ3 THEN

PRINT(" The height difference (h) must be ≤ 2ᴇ3\_m");

BREAK;

END;

IF h<-1ᴇ3 THEN

PRINT(" The height difference (h) must be < -1ᴇ3\_m");

BREAK;

END;

DEFAULT

END;

////////////////////initial clauses (end);

Rg:=287/λ;

Pm:=(2/3)\*((-P1\*P2/(P1+P2))+P1+P2);

ρs:=1.2043\*λ;

///////////////////THEORIC MODEL;

f:=0.02;

C2:=1/√f;

Q:=13.305\*C2\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

V2:=101325\*Q\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R1:=4\*ρs\*Q/(π\*μ\*D);

CASE

IF ε/(D\*1ᴇ3/2)≤2ᴇ−8 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very smooth tube");

BREAK;

END;

IF ε/(D\*1ᴇ3/2)≥0.1 THEN

PRINT(" Check absolute roughness value");

PRINT(" Very rough tube");

BREAK;

END;

IF R1<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3ᴇ3)");

BREAK;

END;

IF R1>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R1<1ᴇ8 THEN

f1:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R1\*sqrt(f1))))))^2,f1,0.03,10);

END;

DEFAULT

END;

C2a:=1/√f1;

Q1:=13.305\*C2a\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

V2a:=101325\*Q1\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R2:=4\*ρs\*Q1/(π\*μ\*D);

CASE

IF R2<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R2>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R2<1ᴇ8 THEN

f2:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R2\*sqrt(f2))))))^2,f2,0.03,10);

END;

DEFAULT

END;

C2b:=1/√f2;

Q2:=13.305\*C2b\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

V2b:=101325\*Q2\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R3:=4\*ρs\*Q2/(π\*μ\*D);

CASE

IF R3<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R3>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R3<1ᴇ8 THEN

f3:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R3\*sqrt(f3))))))^2,f3,0.03,10);

END;

DEFAULT

END;

Ma1:=V2b/√(k\*Rg\*Tm);

////////////////////WEIMOUTH;

Q4:=137.32\*1\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.6667/101325;

V4:=101325\*Q4\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R4:=4\*ρs\*Q4/(π\*μ\*D);

CASE

IF R4<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R4>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R4<1ᴇ8 THEN

f4:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R4\*sqrt(f4))))))^2,f4,0.03,10);

END;

DEFAULT

END;

Ma4:=V4/√(k\*Rg\*Tm);

////////////////////PANHANDLE-A;

Q5:=D^2.6182\*99.51\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.8539\*Tm\*Zm))^0.5394/101325;

V5:=101325\*Q5\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R5:=4\*ρs\*Q5/(π\*μ\*D);

CASE

IF R5<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R5>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R5<1ᴇ8 THEN

f5:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R5\*sqrt(f5))))))^2,f5,0.03,10);

END;

DEFAULT

END;

Ma5:=V5/√(k\*Rg\*Tm);

////////////////////PANHANDLE-B;

Q6:=D^2.53\*137.24\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.9608\*Tm\*Zm))^0.51/101325;

V6:=101325\*Q6\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R6:=4\*ρs\*Q6/(π\*μ\*D);

CASE

IF R6<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R6>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R6<1ᴇ8 THEN

f6:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R6\*sqrt(f6))))))^2,f6,0.03,10);

END;

DEFAULT

END;

Ma6:=V6/√(k\*Rg\*Tm);

////////////////////IGT;

Q7:=D^2.6667\*88.06\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.8\*Tm\*Zm))^0.5555/101325;

V7:=101325\*Q7\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R7:=4\*ρs\*Q7/(π\*μ\*D);

CASE

IF R7<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R7>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R7<1ᴇ8 THEN

f7:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R7\*sqrt(f7))))))^2,f7,0.03,10);

END;

DEFAULT

END;

Ma7:=V7/√(k\*Rg\*Tm);

////////////////////MUELLER;

Q8:=D^2.724\*87.51\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.74\*Tm\*Zm))^0.5747/101325;

V8:=101325\*Q8\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R8:=4\*ρs\*Q8/(π\*μ\*D);

CASE

IF R8<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R8>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R8<1ᴇ8 THEN

f8:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R8\*sqrt(f8))))))^2,f8,0.03,10);

END;

DEFAULT

END;

Ma8:=V8/√(k\*Rg\*Tm);

////////////////////FTITZSCHE;

Q9:=D^2.6911\*94.26\*1\*n\*293.15\*1\*(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ^0.858\*Tm\*Zm))^0.5382/101325;

V9:=101325\*Q9\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

R9:=4\*ρs\*Q9/(π\*μ\*D);

CASE

IF R9<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF R9>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<R9<1ᴇ8 THEN

f9:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(R9\*sqrt(f9))))))^2,f9,0.03,10);

END;

DEFAULT

END;

Ma9:=V9/√(k\*Rg\*Tm);

////////////////////AGA-A;

C2c:=2\*Ca\*LOG((R3\*√f3)/2.51);

Qa:=13.303\*C2c\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

Va:=101325\*Qa\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

Ra:=4\*ρs\*Qa/(π\*μ\*D);

CASE

IF Ra<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF Ra>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<Ra<1ᴇ8 THEN

fa:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(Ra\*sqrt(fa))))))^2,fa,0.03,10);

END;

DEFAULT

END;

C2d:=2\*Ca\*LOG((Ra\*√fa)/2.51);

Qa1:=13.303\*C2d\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

Va1:=101325\*Qa1\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

Ra1:=4\*ρs\*Qa1/(π\*μ\*D);

Maa:=Va1/√(k\*Rg\*Tm);

////////////////////AGA-B;

C2e:=2\*LOG(3.7\*D/(ε\*1ᴇ−3));

Qb:=13.303\*C2e\*n\*293.15\*1\*sqrt(((-2\*9.81\*h\*λ\*Pm^2/(287\*Tm\*Zm))+P1^2-P2^2)/(L\*λ\*Tm\*Zm))\*D^2.5/101325;

Vb:=101325\*Qb\*Tm\*Zm/((π\*D^2/4)\*P2\*293.15\*1);

Rb:=4\*ρs\*Qb/(π\*μ\*D);

CASE

IF Rb<30ᴇ3 THEN

PRINT(" Check ΔP, very low speed (Re<30ᴇ3)");

BREAK;

END;

IF Rb>1ᴇ8 THEN

PRINT(" Check ΔP, very high speed (Re>1ᴇ8)");

BREAK;

END;

IF 30ᴇ3<Rb<1ᴇ8 THEN

fb:=ITERATE((1/(-2\*log10((ε\*1ᴇ−3/(3.7\*D))+(2.51/(Rb\*sqrt(fb))))))^2,fb,0.03,10);

END;

DEFAULT

END;

Mab:=Vb/√(k\*Rg\*Tm);

////////////////////EROSION SPEED;

Ve:=120/√(P2/(Zm\*Rg\*Tm));

Vm:=0.5\*Ve;

///////////////plot;

PRINT(" Ⅰ) THEORIC");

PRINT(" f = "+STRING(f3,3,4));

PRINT(" Re = "+STRING(R3,3,2));

PRINT(" Ma = "+STRING(Ma1,2,3));

PRINT(" V = "+STRING(V2b\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q2\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅱ) WEIMOUTH");

PRINT(" f = "+STRING(f4,3,4));

PRINT(" Re = "+STRING(R4,3,2));

PRINT(" Ma = "+STRING(Ma4,2,3));

PRINT(" V = "+STRING(V4\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q4\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅲ) PANHANDLE-A");

PRINT(" f = "+STRING(f5,3,4));

PRINT(" Re = "+STRING(R5,3,2));

PRINT(" Ma = "+STRING(Ma5,2,3));

PRINT(" V = "+STRING(V5\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q5\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅳ) PANHANDLE-B");

PRINT(" f = "+STRING(f6,3,4));

PRINT(" Re = "+STRING(R6,3,2));

PRINT(" Ma = "+STRING(Ma6,2,3));

PRINT(" V = "+STRING(V6\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q6\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅴ) IGT");

PRINT(" f = "+STRING(f7,3,4));

PRINT(" Re = "+STRING(R7,3,2));

PRINT(" Ma = "+STRING(Ma7,2,3));

PRINT(" V = "+STRING(V7\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q7\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅵ) MUELLER");

PRINT(" f = "+STRING(f8,3,4));

PRINT(" Re = "+STRING(R8,3,2));

PRINT(" Ma = "+STRING(Ma8,2,3));

PRINT(" V = "+STRING(V8\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q8\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅶ) FTITZSCHE");

PRINT(" f = "+STRING(f9,3,4));

PRINT(" Re = "+STRING(R9,3,2));

PRINT(" Ma = "+STRING(Ma9,2,3));

PRINT(" V = "+STRING(V9\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Q9\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅷ) AGA-A");

PRINT(" f = "+STRING(fa,3,4));

PRINT(" Re = "+STRING(Ra1,3,2));

PRINT(" Ma = "+STRING(Maa,2,3));

PRINT(" V = "+STRING(Va1\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Qa1\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" Ⅸ) AGA-B");

PRINT(" f = "+STRING(fb,3,4));

PRINT(" Re = "+STRING(Rb,3,2));

PRINT(" Ma = "+STRING(Mab,2,3));

PRINT(" V = "+STRING(Vb\*1\_(m/s),2,1));

PRINT(" Qstd = "+STRING(Qb\*86400\*1\_(m^3/d),2,0,0));

PRINT(" ");

PRINT(" EROSION & DUCT PRESSURE GRADIENT:");

IF V2b≥20 THEN

PRINT(" Not Recommended Speeds");

ELSE

PRINT(" Erosion Velocity ≅ "+STRING(Ve\*1\_(m/s),2,1));

PRINT(" Recommended Max. ≅ "+STRING(Vm\*1\_(m/s),2,1));

END;

PRINT(" Ideal ΔP/L = 10 < ΔP/L < 25\_kPa/km");

PRINT(" Gas Pipeline ΔP/L = "+STRING(((P1-P2)/L)\*1\_(kPa/km),2,1));

END;