1 Input DATA

1.1 Profile

Weight\_profile [kg/m] {0....10^6}

Type\_profile [] {flat,hollow}

MinWT [mm] {0....10^6}

MaxWT [mm] {0....10^6}

Number of Mandrels [1…100]

Width\_profile [mm] {0....10^6}

Hight\_profile [mm] {0....10^6}

Alloy [table\_alloys]

Surface [table\_surfaces]

Costumer\_lenght\_profile [mm] {0....10^6}

Usage\_profile [mm] {0....10^6}

Complexity [table\_complexity]

Nbr\_cavity [auto, manual] [1 – max\_cavity]

Speed\_extrusion [auto, manual] [0,1 – Max\_pullerspeed](mm/s)

Scrap\_length [auto, manual](m)

1.2 Press

Name\_press

Dia\_container [mm] {0....10^6}

Dia\_billet [mm] {0....10^6}

Lenght\_container [mm] {0....10^6}

Max\_ramspeed (mm/s)

Max\_pullerspeed (mm/s)

Lenght\_cooltable [m] {0....10^6}

Jump\_billet [mm] {0....10^6}

Deadcycle [s] {0....10^6}

Max\_cavity {0....100}

Material\_used

Value\_spreading (%)

Max\_width\_profile (mm)

Min\_buttend = [mm]

Ratio\_extrusion\_min = []

Ratio\_extrusion\_max =[]

Weight\_billet1m = Dia\_bille^2\*pi/4 \* rho\_alloy /1000. (kg)

Weight\_billet1m\_compressed = Dia\_container^2\*pi/4 \* rho\_alloy /1000 (kg)

Press\_Prematerial = [Log / Billet ]

FixCostType1 =[]

FixCostType2 = []

FixCostType3 =[]

Die\_TypeA\_dia = [mm]

Die\_TypeA\_height= [mm]

Remelt\_cost = () €/kg

Margin\_win = (%) standard 7

2) Tables

2.1 table\_alloys

Name\_alloy

Extrudability\_alloy [quot] [0,1-1,0]

Lenght\_log [mm]

Rho\_alloy = []

2.2 table\_surfaces

Name\_surface

Extrudability\_surface [quot] [0,1-1,0]

2.3 table\_complexity

Name\_complexity

Extrudability\_complexity [quot] [0,1-1,0]

Upcharge\_complexity = () table defined in percent

2.4 table\_dies

Axdistance\_value = (%)

Diebaseprice formula = -2ln(DieTypeA\_weight) +14

DieTypeA\_volume = Die\_TypeA\_dia^2\*pi/4 \* Die\_TypeA\_height /1000 (cm3)

DieTypeA\_weight = DieTypeA\_volume (cm3) \* 7,87 (g/cm3) /1000 -- (kg)

Upcharge\_cavity = (%) standard 5

2.5 table\_usage

Name\_usage []

Rec\_LogRest [yes/no]

3) Calculations for Main\_Flow

3.1 #ofcavity AUTO

Check how many profiles fit into a die. Die is the tool, where the profiles are coming out at production.

Usable\_dia = dia\_container \* ((100+value\_spreading)/100)

Cimcumscribing\_profile = ROOT(Width\_profile^2+Hight\_profile^2)

Extratio\_profile = Weight\_billet1m\_compressed / Weight\_profile

max\_height\_2cav = ROOT((dia\_container/2)^2-((hight\_profile/2)^2) – axdistance\_profile

max\_height\_4cav = ROOT((usable\_dia/2)^2-((hight\_profile+axdistance\_profile)^2) – axdistace\_profile

max\_cs\_6cav = usable\_dia / 3

max\_cs\_8cav = SIN(45)\*(usable\_dia/4)

Axdistance\_profile = dia\_billet \* 1+(axdistance\_value/100)

IF max\_width\_profile > width\_profile  Nbr\_cavity = 0, else

check if 8 cavity possible…

IF {Cimcumscribing\_profile < (max\_cs\_8cav – axdistance\_profile)} AND ratio\_extr\_min < (Extratio\_profile /8) < ratio\_extr\_max AND Max\_cavity <=8  Nbr\_cavity =8, else

check if 6 cavity possible…

IF Cimcumscribing\_profile < (max\_cs\_6cav – axdistance\_profile) AND ratio\_extr\_min < (Extratio\_profile /6) < ratio\_extr\_max AND Max\_cavity <=6  Nbr\_cavity =6, else

check if 4 cavity possible

IF Width\_profile < max\_height\_4cav OR Cimcumscribing\_profile < (usable\_dia/2 – axdistance\_profile) AND ratio\_extr\_min < (Extratio\_profile /4) < ratio\_extr\_max AND Max\_cavity <=4  Nbr\_cavity =4, else

Check if 2 cavity possible

IF Width\_profile < max\_height\_2cav OR Cimcumscribing\_profile < (usable\_dia/2 – axdistance\_profile/2) AND ratio\_extr\_min < (Extratio\_profile /2) < ratio\_extr\_max AND Max\_cavity <=2  Nbr\_cavity =2, else

Check if 1 cavity possible

IF Cimcumscribing\_profile < usable\_dia AND ratio\_extr\_min < Extratio\_profile < ratio\_extr\_max  Nbr\_cavity =1, else Nbr\_cavity =0

3.2 extrusion Speed AUTO

ramspeed = max\_ramspeed \* Extrudability\_alloy \* Extrudability\_surface \* Extrudability\_complexity

3.3 scrap length AUTO

Length\_scrap = []

3.4 Butt end AUTO

Length\_buttend = []

3.5 Billet length

Volume\_rate\_container\_billet = Dia\_containerr^2 / Dia\_billet^2

Ratio\_extrusion = Weight\_billet1m\_compressed / Weight\_profile / Nbr\_cavity

Max\_produceable\_lenght = ((Lenght\_container / Volume\_rate\_container\_billet) – length\_buttend) \* Ratio\_extrusion /1000

Max\_producable\_costlen = (Max\_produceable\_lenght - Length\_scrap) / (Costumer\_lenght\_profile/1000) – rount DOWN to FULL numbers {1,2,3,…10^3}

Max\_producable\_cl\_table = (Lenght\_cooltable - Length\_scrap) / (Costumer\_lenght\_profile/1000 – rount DOWN to FULL numbers {1,2,3,…10^3}

Number\_costumer\_length = MIN(Max\_producable\_cl\_table; Max\_producable\_costlen)

Weight\_nbr\_cslenght = Number\_costumer\_length \* (Costumer\_lenght\_profile/1000) \* Weight\_profile

Weight\_buttend = length\_buttend \* Weight\_billet1m\_compressed/1000

Weight\_billetlength = (Weight\_nbr\_cslenght\*Nbr\_cav) + Weight\_buttend + (weight\_scrap\*Nbr\_cav)

Length\_billet = Weight\_billetlength / Weight\_billet1m \*1000

Length\_billet\_compressed = Length\_billet / Volume\_rate\_container\_billet

3.5 Productivity

Time\_extrusion\_billet = (Length\_billet\_compressed-length\_buttend) / ramspeed

Time\_process = Time\_extrusion\_billet + Deadcycle

Net\_productivity = (Weight\_nbr\_cslenght\*Nbr\_cav) / Time\_process \*3600

Gros\_productivity = Weight\_billetlength / Time\_process \*3600

3.6 Recovery

3.6.1 Recover per Billet (%)

Recovery\_billet = Weight\_nbr\_cslenght / Weight\_billetlength – in percent

3.6.2 Recovery per Log (%)

Nbr\_billets\_in\_log = length\_log/ billet\_length ROUND to full numbers

Log\_restpiece = length\_log – (Nbr\_billets\_in\_log \* length\_billet)

Weight\_log\_restpiece = log\_restpiece \* weigth\_billet1m

Weight\_log\_restpiece\_billet = Wegth\_log\_rertpiece / Nbr\_billets\_in\_log

If (Press\_Prematerial (table\_press) = Billet  Recovery\_log = 0)

Else if (Recovery\_LogRest (table\_usage) = yes  Recovery\_log = 0)

Else if (

Recoveryloss\_log = Recovery\_billet - (Weight\_nbr\_cslenght / (Weight\_billetlength + Weight\_log\_restpiece\_billet))

3.6.3 Recovery \_total (%)

Recovery\_total = Recovery\_billet + Recoveryloss\_log

4. CostCalculation

4.1 Die Cost (german: Werkzeugkosten )

4.1.1 Die Price

Die\_price\_base = if Type\_profile is flat, Diebaseprice\_formula \* 0,5 ; Else if Diebaseprice\_formula

Dp\_upcharge\_cavity = Die\_price\_base \* (((Nbr\_cavity –1) \* Upcharge\_cavity )/100)

Dp\_upcharge\_compl = die\_price\_base \* (Upcharge\_complexity /100)

Die\_Price = Die\_price\_base + dp\_upcharge\_cavity + dp\_upcharge\_compl

4.1.2 Die Life

DieLife = Extrudability\_complexity \* 100000

Die\_Cost = Die\_price / DieLife (€/kg)

4.2 Productivity Cost

FixCost 1 = FixCostType1 / Net\_productivity (german Bereichskosten)

FixCost 2 = FixCostType2 / Net\_productivity (german Werkskosten)

FixCost3 = FixCostType3 / Net\_productivity (german BU SGA)

Productivity\_cost = FixCost 1 + FixCost 2 + FixCost 3

4.3 Freight Cost (german Frachtkosten)

Use 0,07

4.4 Packing Cost (german Verpackungkosten)

Use 0,07

4.5 Recovery\_loss

Recovery\_loss\_cost = (100- recovery\_total \* remelt\_cos) / (recovery\_total) -- see in excel

4.6 Extrusion\_margin

Total\_cost = Die\_Cost + Productivity\_cost + Freight Cost + Packing Cost + Recovery\_loss

Win = total\_cost \* (margin\_win/100)

Extrusion\_margin = total\_cost + Win