

• Mendeleev University of Chemical  
• Technology of Russia (MUCTR)

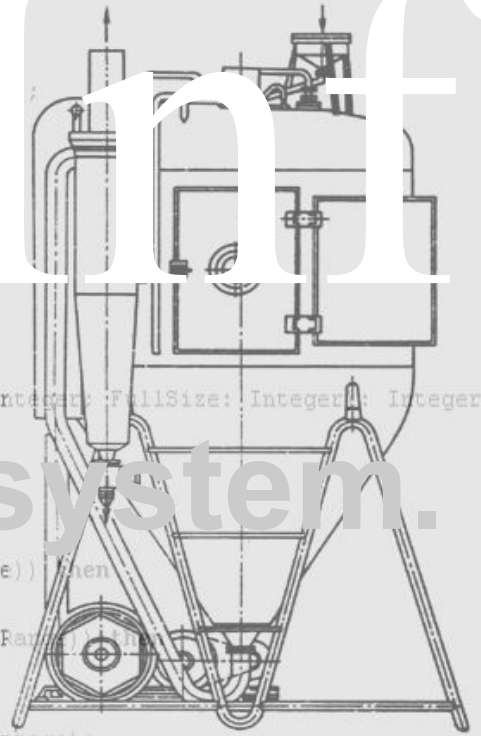
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# DryInf

## Information system.

```
Right := Tmp;
...
procedure ... (Left, Right: Integer;
var
    Tmp: Integer;
begin
    Tmp := Left;
    Left := Right;
    Right := Tmp;
end;

function PercentToAbsolute(Percentage: Integer; FullSize: Integer; Integer;
var
    Percent: Integer;
begin
    { guard against out of range }
    if (Percentage > High(TPercentRange)) then
        Percent := High(TPercentRange)
    else if (Percentage < Low(TPercentRange)) then
        Percent := Low(TPercentRange)
    else
        Percent := TPercentRange(Percentage);
```



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# Aims...

- **Summarize and accumulate human experience**
- **Intelligent aid while design**
- **Knowledge and experience sharing**

# “DryInf” benefits...

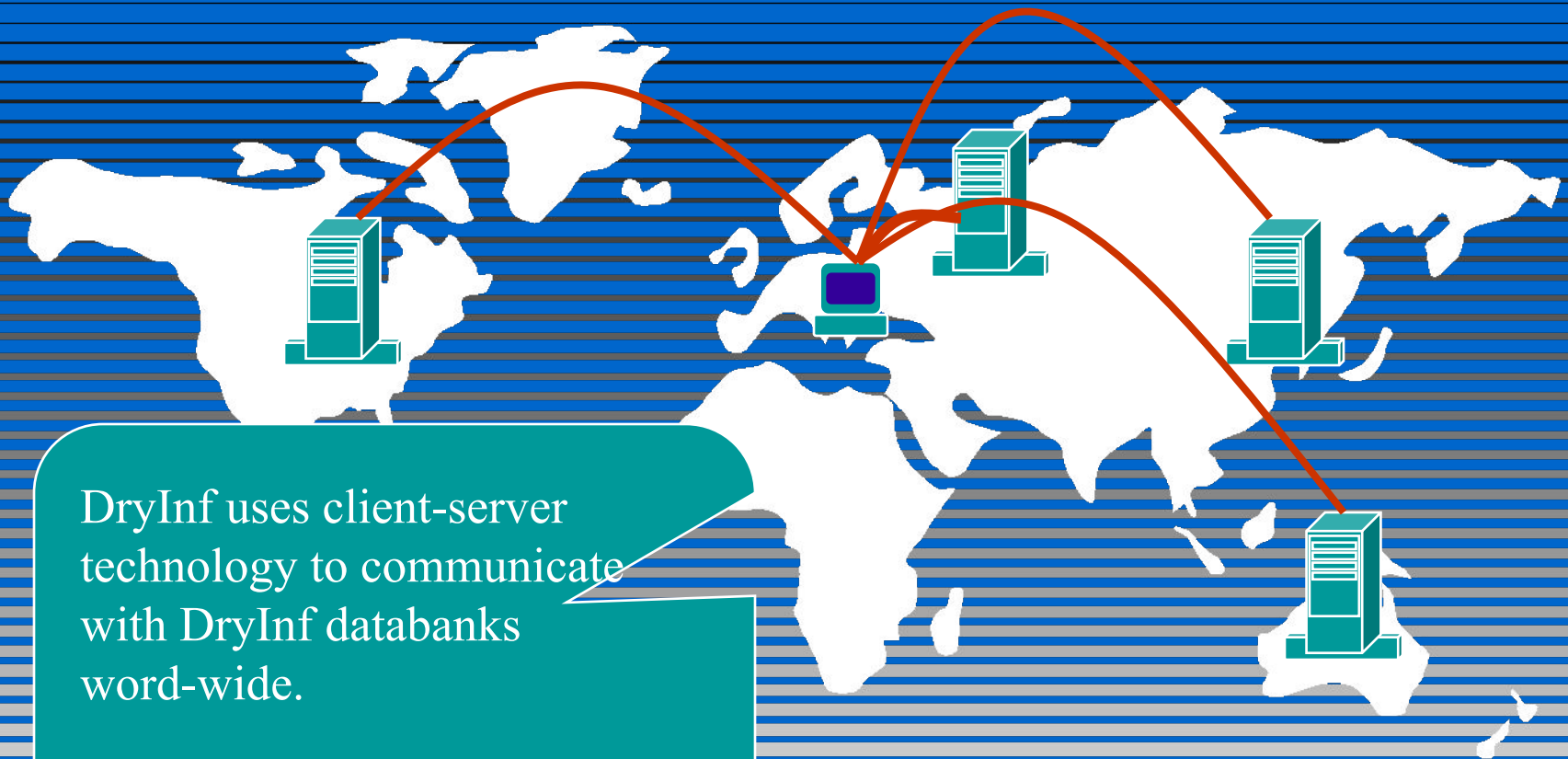
- **Table of estimations**

- 5 scale type of grades making transfer of knowledge from human to machine easy.
- Upgrading databases allows knowledge to be accumulated and shared.

- **Information word-wide**

- No more problem to download or upgrade database.
- Get connected to one or more databases at one session!
- Internet, local network or hard drive these all available.

# Information world-wide



DryInf uses client-server technology to communicate with DryInf databanks word-wide.

# “DryInf” benefits...

- **Modular technology**

- All functions of this system are “plug-in’s”, all of them user can enable or disable.
- Application Program Interface (DryInf API) provides simple and fast mechanism to integrate other applications into DryInf.

- **“Wizard“ style of user interface**

- User should not think likely “How to work with it?”, he just start to work immediately.
- Highly understandable interface is very comfortable for beginners.



# “DryInf” structure

DryInf works with databases. They could be local or remote. Each database includes one or more databank

Each databank consist of:

- **Apparatuses table**
- **Questionnaire table**
- **Sets of possible answers table**
- **Estimations table**

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# “DryInf” structure

Simply, the databank structure could be presented as follows:

Device name	Question 1		Question 2	
	Answer 1	Answer 2	Answer 1	Answer 2
Device 1	5	5	3	0
Device 2	4	3	3	5
...	...	...	...	...

There questions are in “questionnaire” table of databank, answers are in “sets of possible answers” table, devices are in apparatuses table and, finally, numbers are an expert estimations for each apparatus and stored in “estimations” table.

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## “DryInf” structure

Selection of estimations for each device as follows (rules):

**For Device1:**

**If for Question1 answer Answer1 then**

estimation = previous estimation + new estimation

**If for Question2 answer Answer2 then**

estimation = 0 and exit for Device1.

*{Comments: if system get zero as new estimation it results to all previous estimation sum zeroed and device become marked “NOT USED”. If not, get continue to the end of questionnaire and get final sum as result of calculation}*

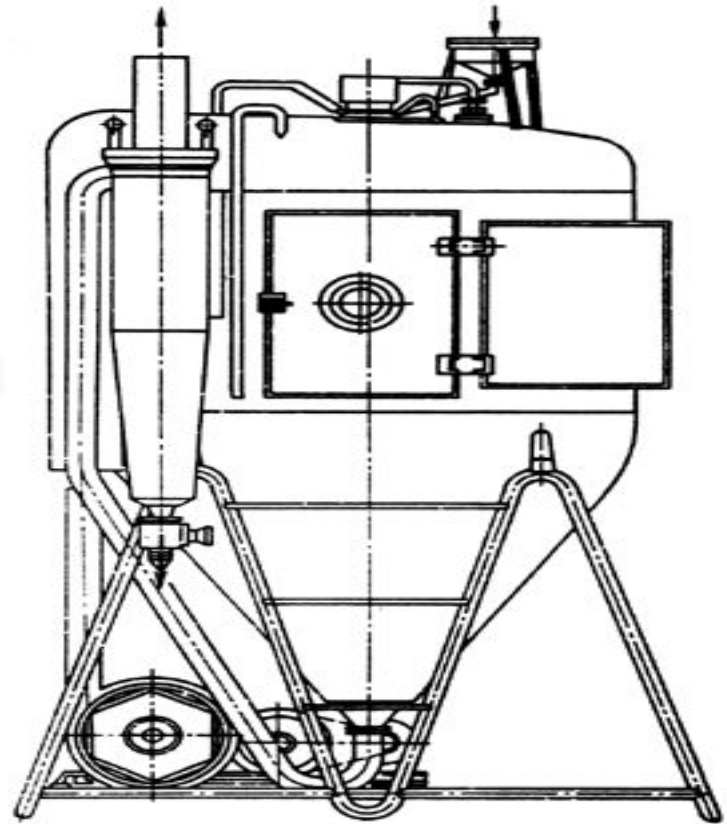


# Example of databank structure

Type of dryer	Dryer capacity			Drying time					
	low	middle	high	<3 sec	3-30 sec	0.5-2 min	2-20 min	10-60 min	> 1 hour
Shelf dryer	5	3	0	0	0	0	3	5	5
Spray dryer-granulator	5	3	0	0	0	0	3	5	0
.....									
Cylinder dryer	3	5	5	0	5	3	0	0	0
Rotary vacuum dryer	5	5	0	0	0	0	3	5	5
Fluidized bed dryer	5	5	5	0	0	3	5	5	0
Batch fluidized bed dryer	5	5	0	0	0	0	3	5	5
Impinging stream dryer	5	5	3	5	3	0	0	0	0

# About “32 dryers” databank

- This databank is shipped with DryInf as local database.
- It was developed with the aim to facilitate selection of the most appropriate dryer for a given material



# Types of dryers used in databank

## “32 dryers”

	Type of dryer		Type of dryer
1	Shelf dryer	17	Belt dryer
2	Vacuum shelf dryer	18	Multi-belt dryer
3	Spray dryer with disc atomizer	19	Combined cylinder-belt dryer
4	Spray dryer with nozzle atomizer	20	Vibrated bed dryer
5	Pulsed combustion spray dryer	21	Fluidized bed dryer
6	Spray dryer-granulator	22	Fluidized bed dryer with inert particles
7	Cylinder dryer	23	Batch fluidized bed dryer
8	Vacuum cylinder dryer	24	Spouted bed dryer
9	Rotary direct dryer	25	Vortex dryer
10	Rotary indirect dryer	26	Vortex dryer with disintegrator
11	Rotary dryer-granulator	27	Pneumatic dryer
12	Rotary vacuum dryer	28	Pneumatic dryer with disintegrator
13	Drum dryer with heated rotor	29	Cyclone dryer
14	Vacuum drum dryer with heated rotor	30	Spiral dryer
15	Tumbler dryer	31	Impingement dryer
16	Screw conveyor dryer	32	Impinging stream dryer

# DIDE

**DIDE** is DryInf data editor.

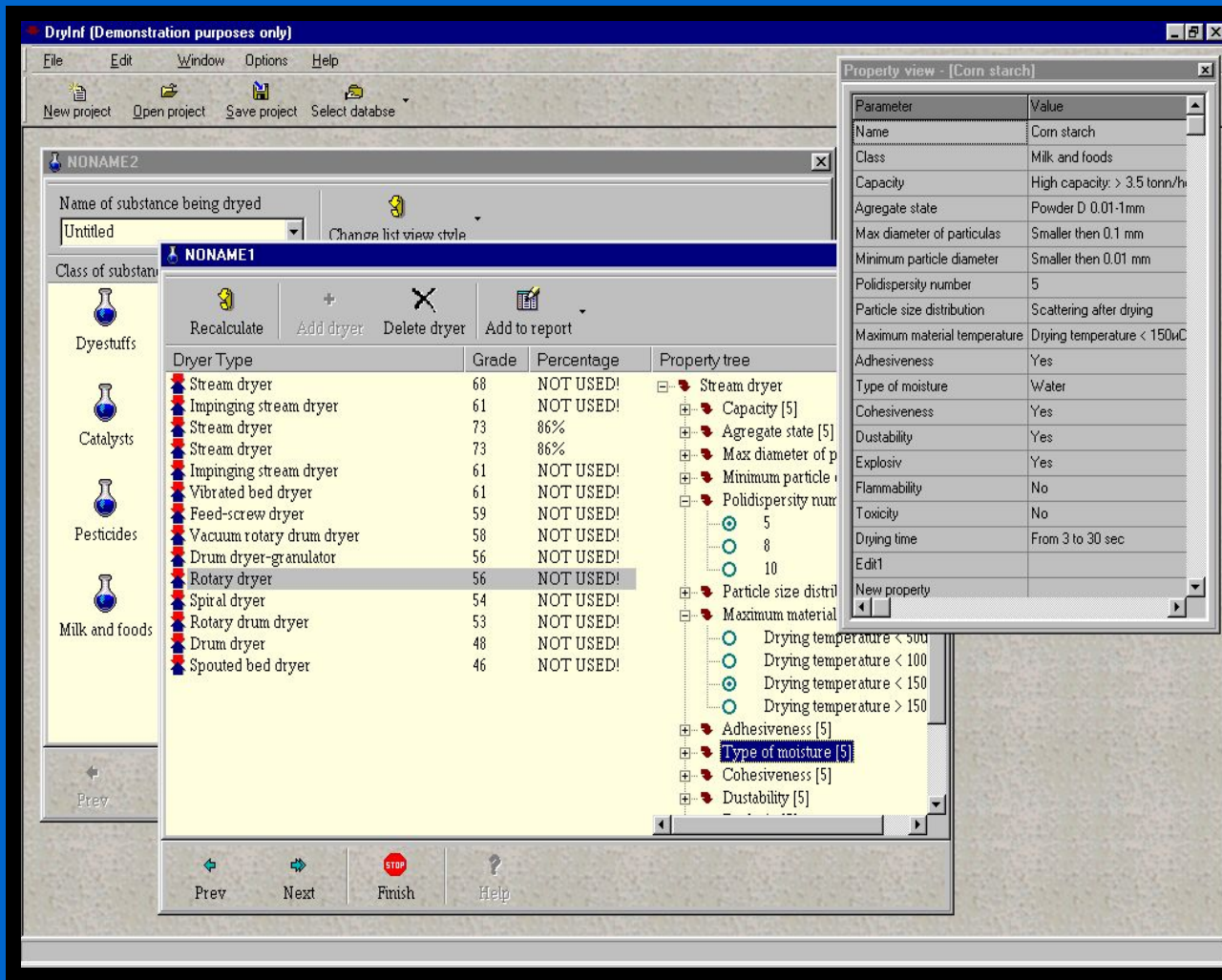
**DIDE** allows user to change data in databank or create another. To work with **DIDE** user have to be an expert and have permission to write in databank.

⋮  
Have a look on this system...



DryInf

# Main window



By using main menu or toolbuttons user can start new project or open existent

# Class and name

**DryInf (Demonstration purposes only)**

File Edit Window Options Help

New project Open project Save project Select database

**NONAME1**

Name of substance being dried  
Untitled

Class of substance being dried.

Dyestuffs Organic chemicals Ceramics  
Catalysts Inorganic chemicals  
Pesticides Pharmaceuticals  
Milk and foods Polymers

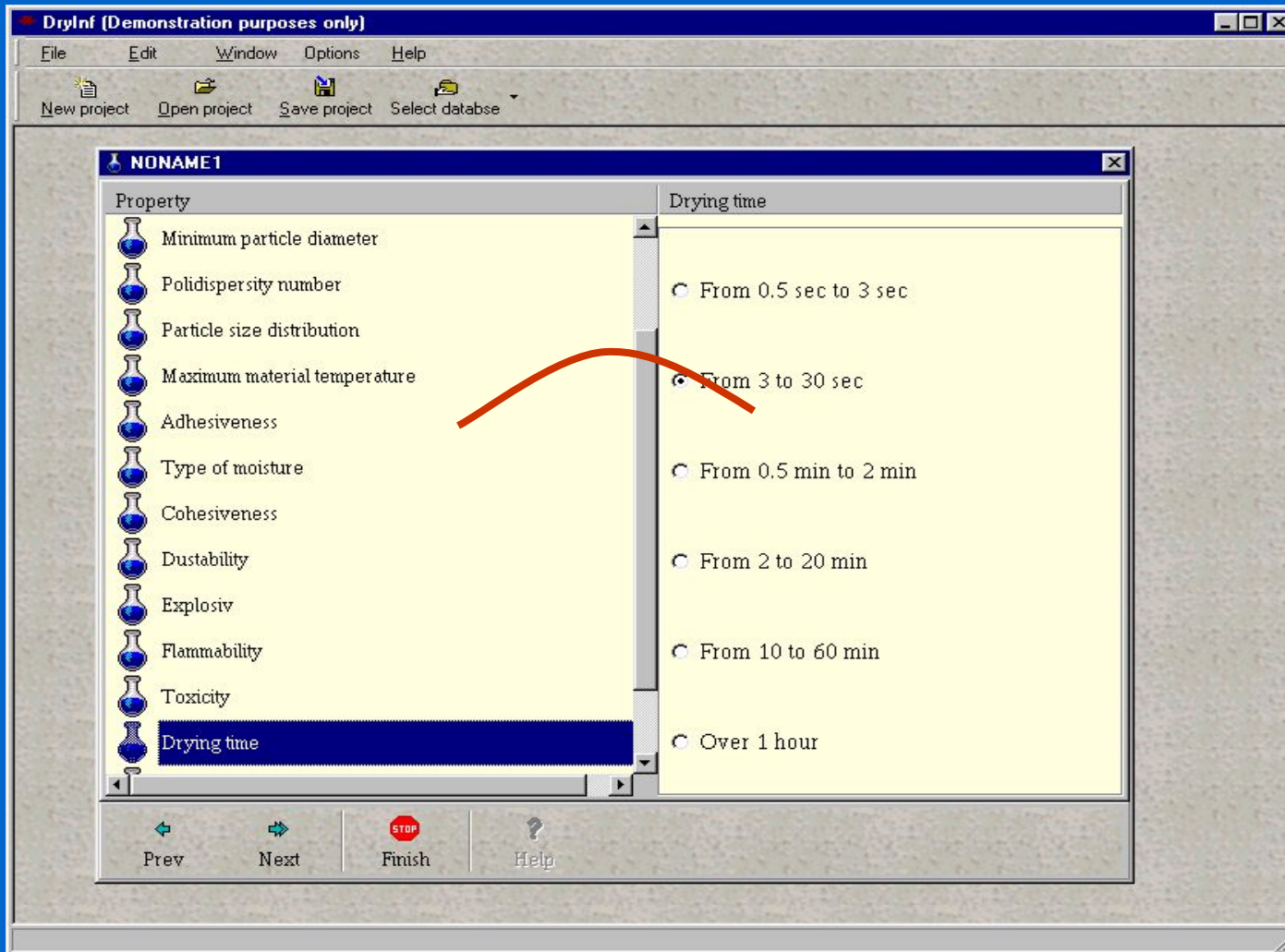
**Property view - [Corn starch]**

Parameter	Value
Name	Corn starch
Class	Organic chemicals
Capacity	High capacity: > 3.5 tonn/h
Agregate state	Powder D 0.01-1mm
Max diameter of particulas	Smaller then 0.1 mm
Minimum particle diameter	Smaller then 0.01 mm
Polidispersity number	5
Particle size distribution	Bad scatter
Maximum material temperature	Drying temperature < 150°C
Adhesiveness	Yes
Type of moisture	Water
Cohesiveness	Yes
Dustability	Yes
Explosiv	Yes
Flammability	No
Toxicity	No
Drying time	From 3 to 30 sec

Prev Next Finish Help

- In this first wizard window user have to select a class of substance being processed and enter name or id of this one.
- At the right side of window all entered properties will be dynamically updated.

# Specify properties of substance



At this window  
all  
substance  
properties  
must be  
specified.



# See the result

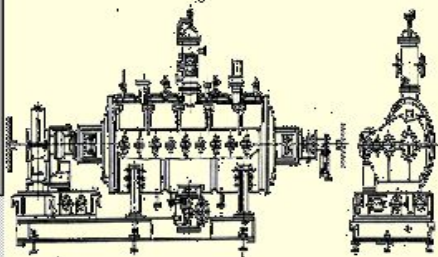
DryInf (Demonstration purposes only)

File Edit Window Options Help

New project Open project Save project Select database

NONAME1

Select dryers Show selected dryer

Dryer type	Score	Percentage	Picture
<input checked="" type="checkbox"/> Stream dryer	73	86%	
<input checked="" type="checkbox"/> Flash spray dryer	70	NOT US.	
<input checked="" type="checkbox"/> Rotary spray dryer	68	NOT US.	
<input checked="" type="checkbox"/> Nozzle spray dryerw	66	NOT US.	
<input checked="" type="checkbox"/> Impinging stream dryer	61	NOT US.	
<input checked="" type="checkbox"/> Tube pneumatic dryer	61	NOT US.	
<input checked="" type="checkbox"/> Vacuum shaft dryer	61	NOT US.	
<input checked="" type="checkbox"/> Vacuum shell dryer	61	NOT US.	
<input checked="" type="checkbox"/> Vibrated bed dryer	61	NOT US.	
<input checked="" type="checkbox"/> Feed-screw dryer	59	NOT US.	
<input checked="" type="checkbox"/> Shaft dryer	58	NOT US.	
<input checked="" type="checkbox"/> Shell dryer	58	NOT US.	
<input checked="" type="checkbox"/> Vacuum rotary drum dryer	58	NOT US.	
<input checked="" type="checkbox"/> Combined spray dryer-granulator	56	NOT US.	
<input checked="" type="checkbox"/> Cyclone (combined) dryer	56	NOT US.	
<input checked="" type="checkbox"/> Drum dryer-granulator	56	NOT US.	
<input checked="" type="checkbox"/> Fluidized bed dryer with inert particles	56	NOT US.	
<input checked="" type="checkbox"/> Rotary dryer	56	NOT US.	
<input checked="" type="checkbox"/> Shaft-belt dryer	56	NOT US.	
<input checked="" type="checkbox"/> Spiral dryer	54	NOT US.	

Prev Next Finish Help

Here the list of all selected apparatuses will be displayed. Apparatuses sorted in order "best dryer first". Percentage of adequacy is shown.

# Full-sized dryer image

The screenshot shows a software application window titled "DryInf (Demonstration purposes only)". The interface includes a menu bar (File, Edit, Window, Options, Help) and a toolbar with icons for "New project", "Open project", "Save project", and "Select database". Below the toolbar, there is a section labeled "NONAME1" with two buttons: "Select dryer" and "Show selected dryer". The "Show selected dryer" button is circled in red. A table lists various dryer types with their respective scores and percentages. The "Rotary dryer" is selected in the table. To the right of the table, a technical drawing of a rotary dryer is visible. At the bottom of the main window, there are navigation buttons: "Prev", "Next", "Finish", and "Help".

Dryer type	Score	Percentage	Picture
<input checked="" type="checkbox"/> Stream dryer	73	86%	
<input type="checkbox"/> Flash spray dryer	70	NOT US.	
<input type="checkbox"/> Rotary spray dryer	68	NOT US.	
<input type="checkbox"/> Nozzle spray dryerw	66	NOT US.	
<input type="checkbox"/> Impinging stream dryer	61	NOT US.	
<input type="checkbox"/> Tube pneumatic dryer	61	NOT US.	
<input type="checkbox"/> Vacuum shaft dryer	61	NOT US.	
<input type="checkbox"/> Vacuum shell dryer	61	NOT US.	
<input type="checkbox"/> Vibrated bed dryer	61	NOT US.	
<input type="checkbox"/> Feed-screw dryer	59	NOT US.	
<input type="checkbox"/> Shaft dryer	58	NOT US.	
<input type="checkbox"/> Shell dryer	58	NOT US.	
<input type="checkbox"/> Vacuum rotary drum dryer	58	NOT US.	
<input type="checkbox"/> Combined spray dryer-granulator	56	NOT US.	
<input type="checkbox"/> Cyclone (combined) dryer	56	NOT US.	
<input type="checkbox"/> Drum dryer-granulator	56	NOT US.	
<input type="checkbox"/> Fluidized bed dryer with inert particles	56	NOT US.	
<input checked="" type="checkbox"/> Rotary dryer	56	NOT US.	
<input type="checkbox"/> Shaft-belt dryer	56	NOT US.	
<input type="checkbox"/> Spiral dryer	54	NOT US.	
<input type="checkbox"/> ...	...	...	

The "Full sized graphical representation" window displays a detailed technical drawing of a rotary dryer, showing its cylindrical body, support structure, and various mechanical components. A "Close" button is visible at the bottom of this window.

# “Back step“ mode

**DryInf (Demonstration purposes only)**

File Edit Window Options Help

New project Open project Save project Select database

**NONAME1**

Recalculate Add dryer Delete dryer Add to report

Dryer Type	Grade	Percentage	Property tree
Stream dryer	88	NOT USED!	Stream dryer
Impinging stream dryer	61	NOT USED!	Capacity [5]
Stream dryer	73	86%	Aggregate state [5]
Stream dryer	73	86%	Max diameter of particulas [5]
Impinging stream dryer	61	NOT USED!	Minimum particle diameter [5]
Vibrated bed dryer	61	NOT USED!	Polidispersity number [5]
Feed-screw dryer	59	NOT USED!	5
Vacuum rotary drum dryer	58	NOT USED!	8
Drum dryer-granulator	56	NOT USED!	10
Rotary dryer	56	NOT USED!	Particle size distribution [5]
Spiral dryer	54	NOT USED!	Maximum material temperature [5]
Rotary drum dryer	53	NOT USED!	Drying temperature < 50u
Drum dryer	48	NOT USED!	Drying temperature < 100
Spouted bed dryer	46	NOT USED!	Drying temperature < 150
			Drying temperature > 150
			Adhesiveness [5]
			Type of moisture [5]
			Cohesiveness [5]
			Dustability [5]

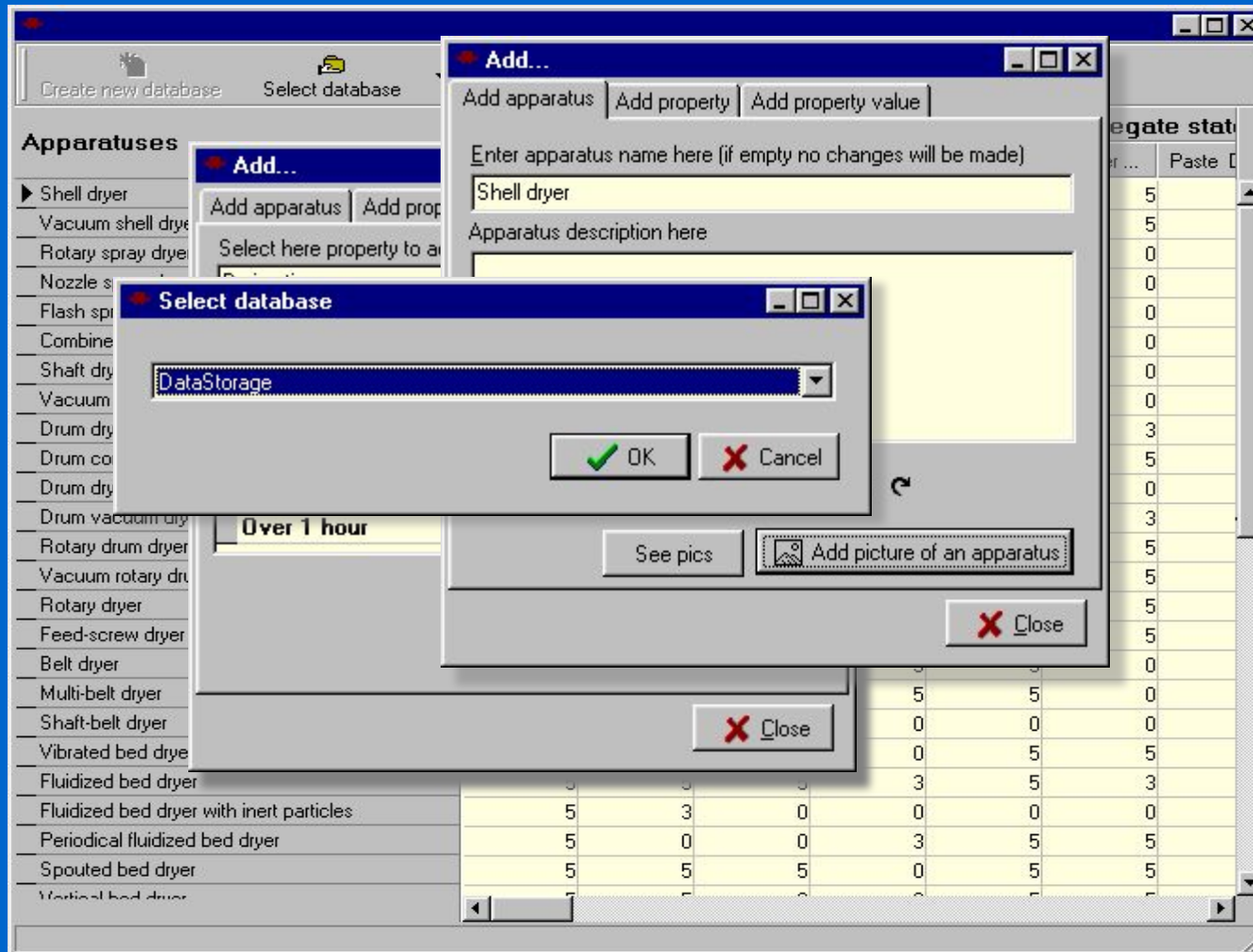
**Property tree (selected):**

- Stream dryer
  - Capacity [5]
  - Aggregate state [5]
  - Max diameter of particulas [5]
  - Minimum particle diameter [5]
    - Polidispersity number [5]
      - 5
      - 8
      - 10
    - Particle size distribution [5]
    - Maximum material temperature [5]
      - Drying temperature < 50u
      - Drying temperature < 100
      - Drying temperature < 150
      - Drying temperature > 150
  - Adhesiveness [5]
  - Type of moisture [5]
  - Cohesiveness [5]
  - Dustability [5]

In this window user can see property tree for each selected earlier device. Property tree displays estimation for each property and allows property adjustment (back step).

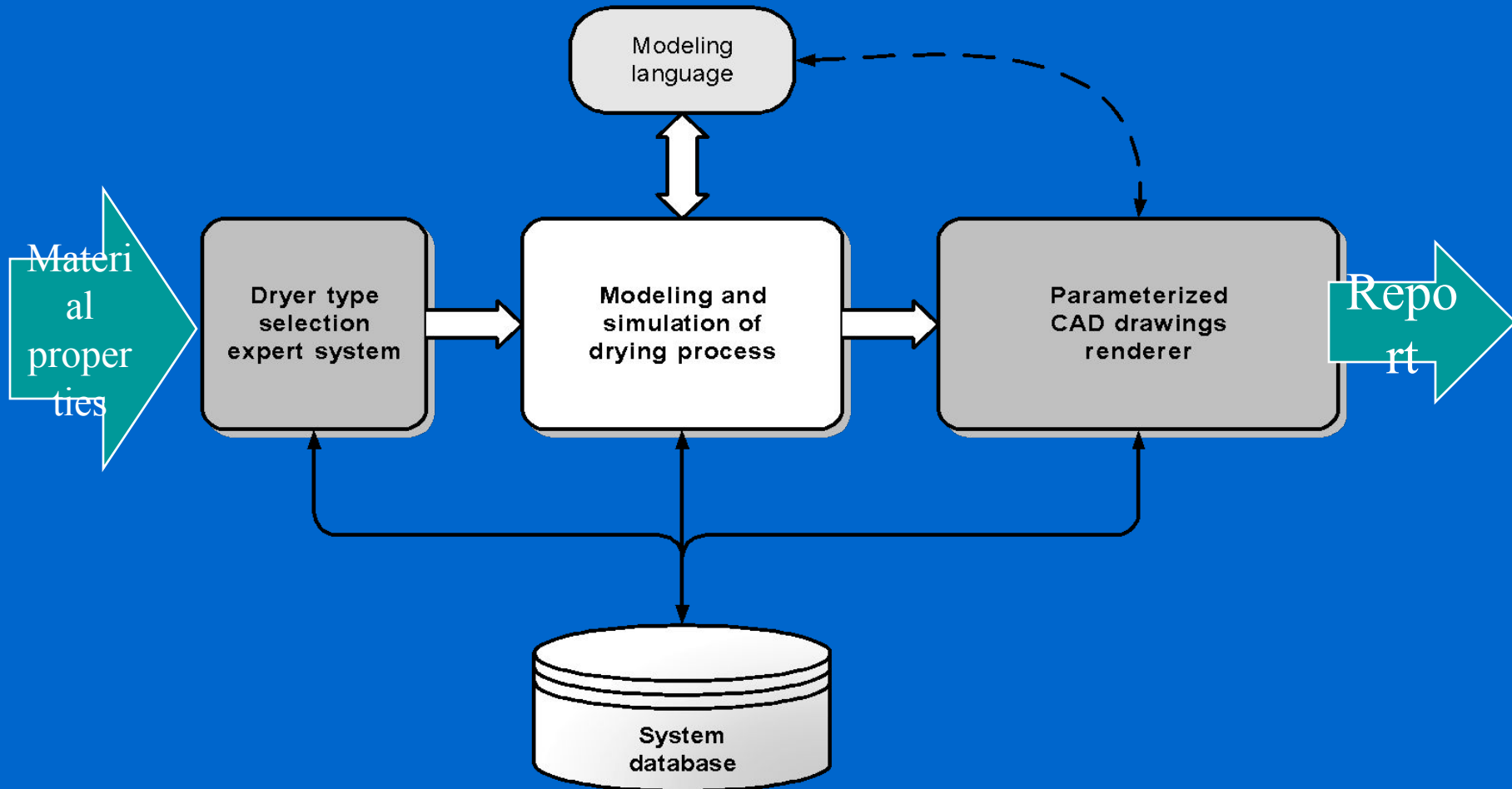
# • DIDE - DryInf Databank Editor

## Add new dryers or properties



- DryInf allows user to act as expert. User can add new apparatuses or properties to databank he connected to.

# Further developments...



# Modeling language

Drying

Heat and mass balance

Hydrodynamic

Kinetic

Modeling language based on Pascal grammar

User functions

Mathematical functions

Matrix operations

Trigonometric functions

Function interpolation

Polynomial and transcendental equations

Extremum search

Integration

Number theory

Power series operation

Polynomial operations

Random number generators

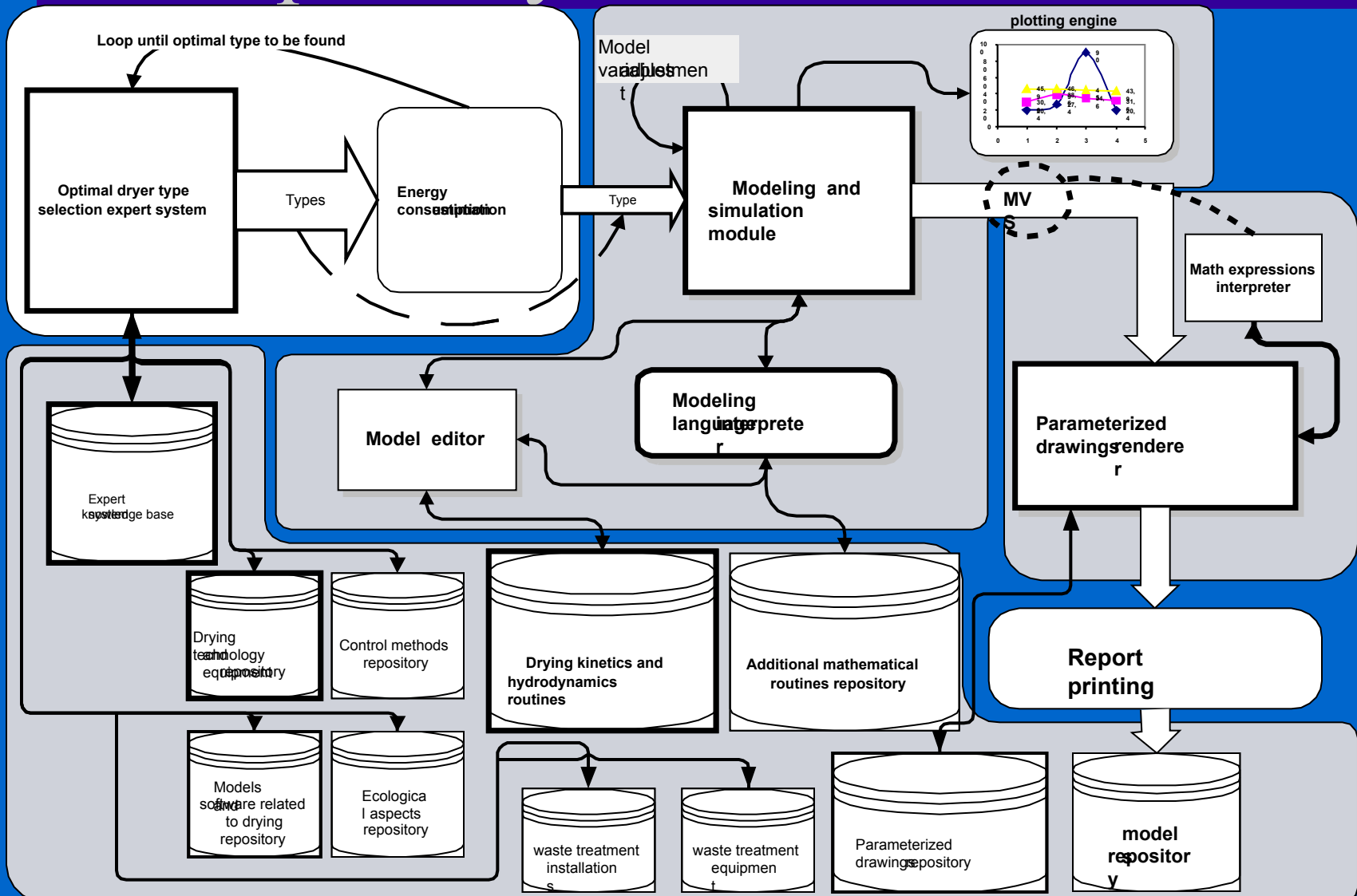
Differential equations

Integral

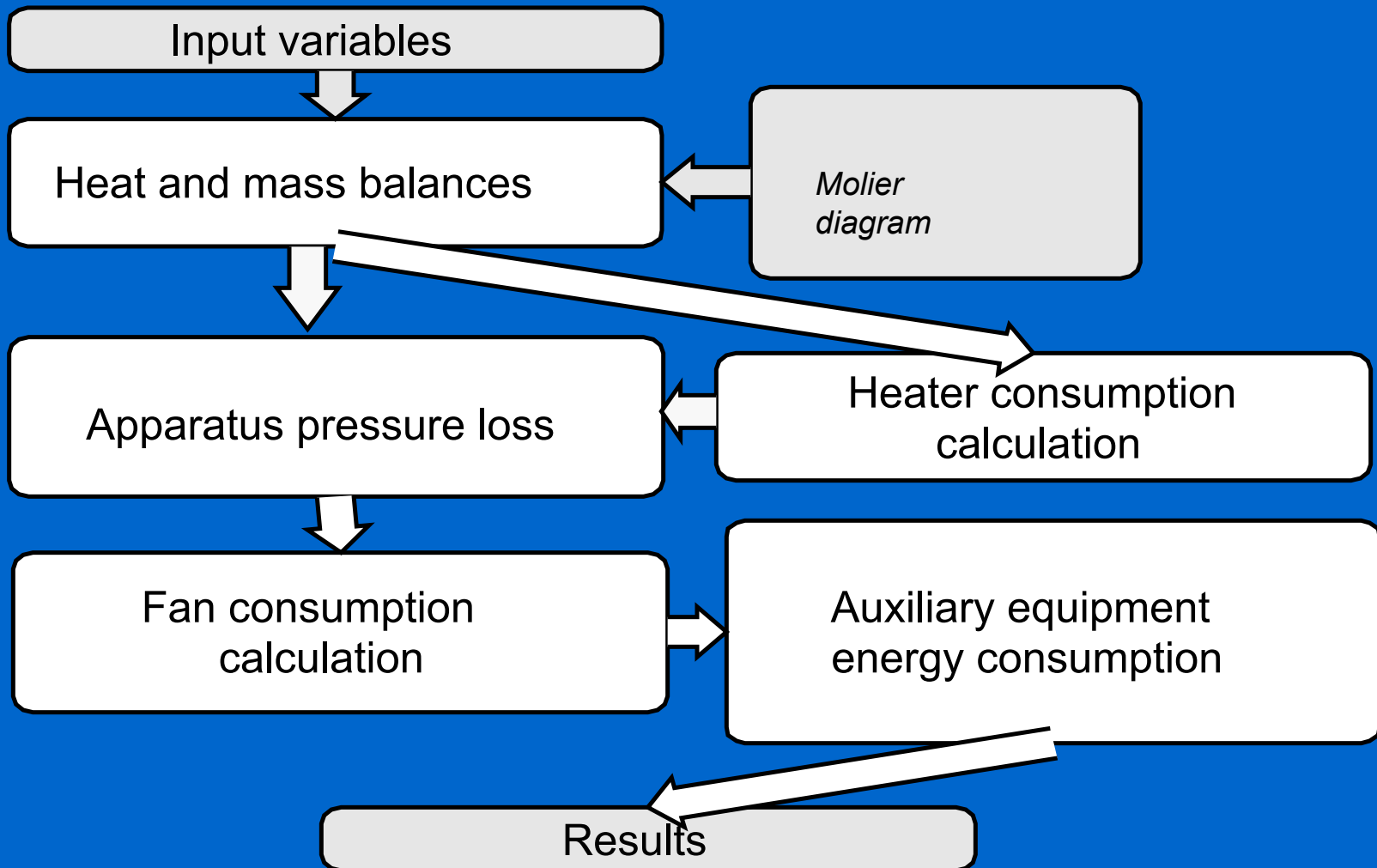
Sortin

Set of algebraic equations

# Conceptual system structure



# Energy consumption calculation





# Modeling scheme

Experimental data

$G_{air}$

$G_{air}, \tau, dm/d\tau$

Hydrodynamics calculation

$$G_{air} = f(d_p)$$

$d_p$

Kinetic model

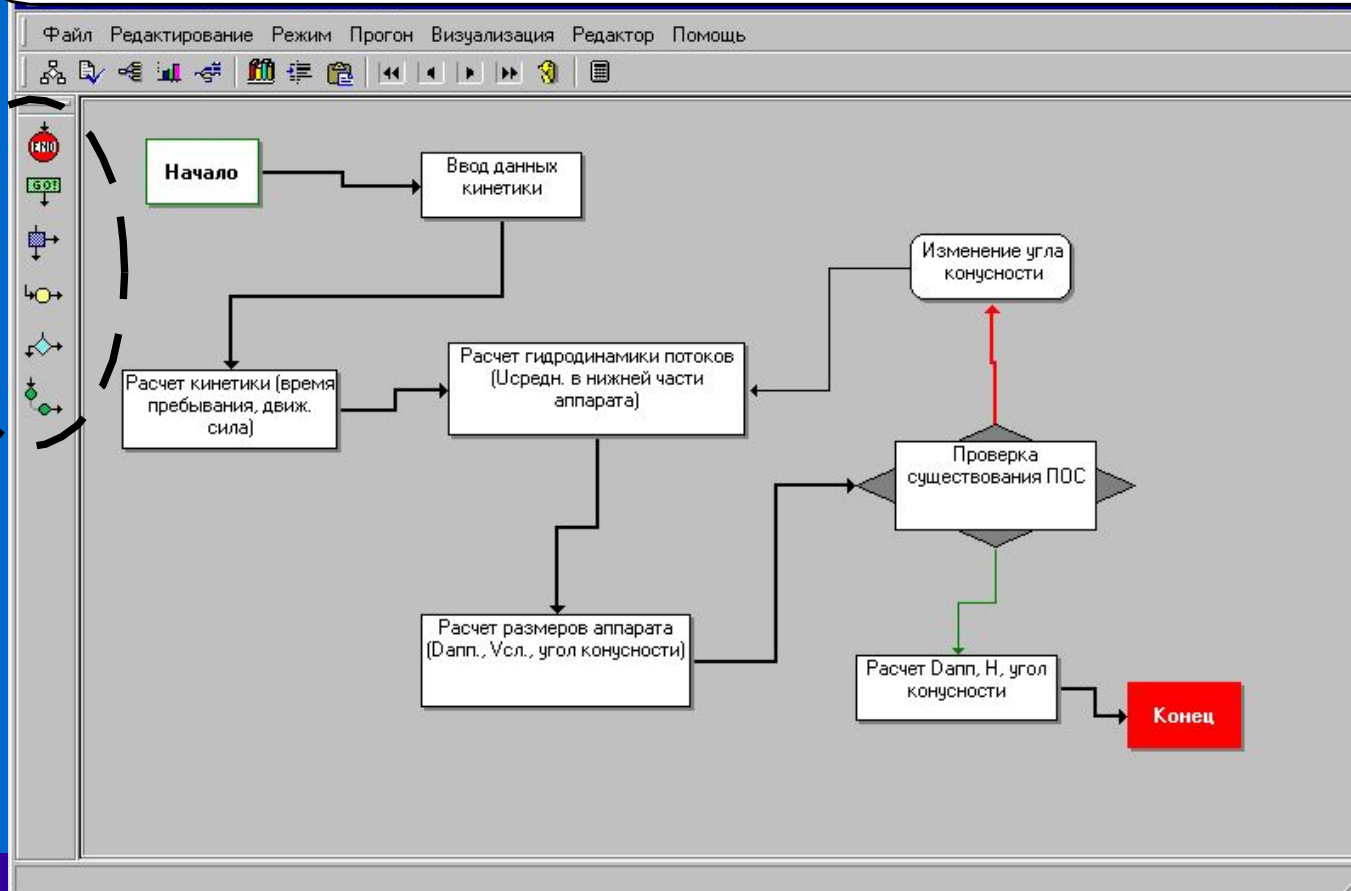
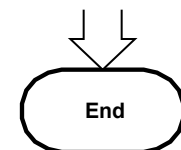
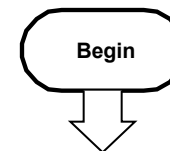
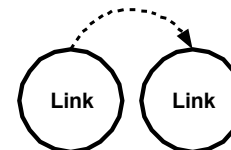
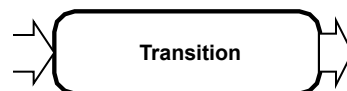
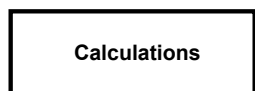
$$\tau = f(G_{air}, d_p)$$

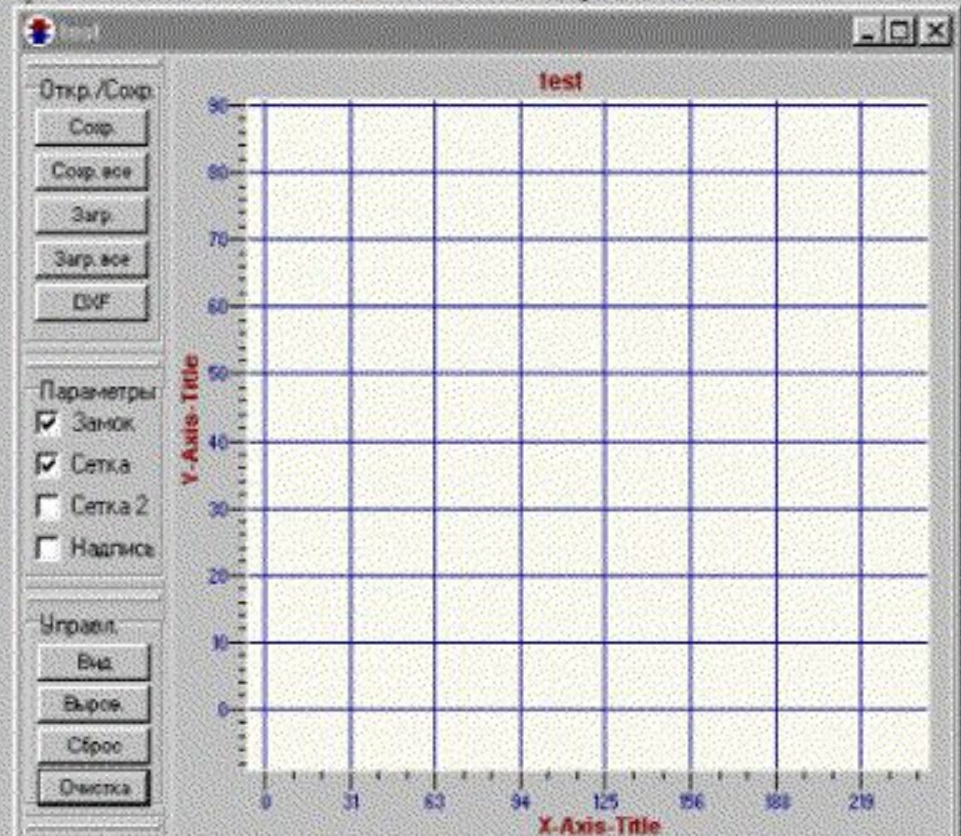
Optimization

$$\text{opt } G_{air}, \tau$$

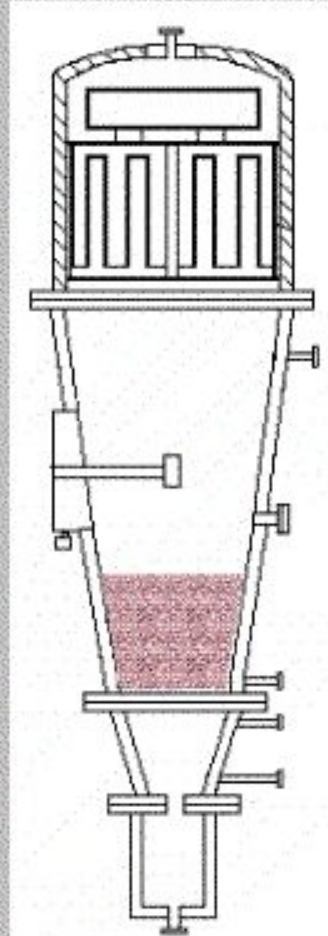
# Visual block modeling

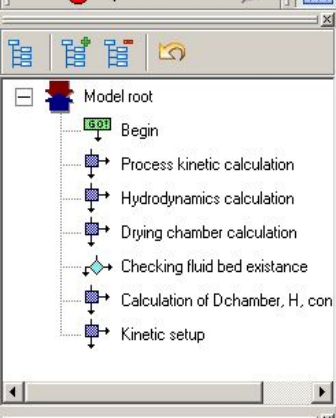
## Modeling elements



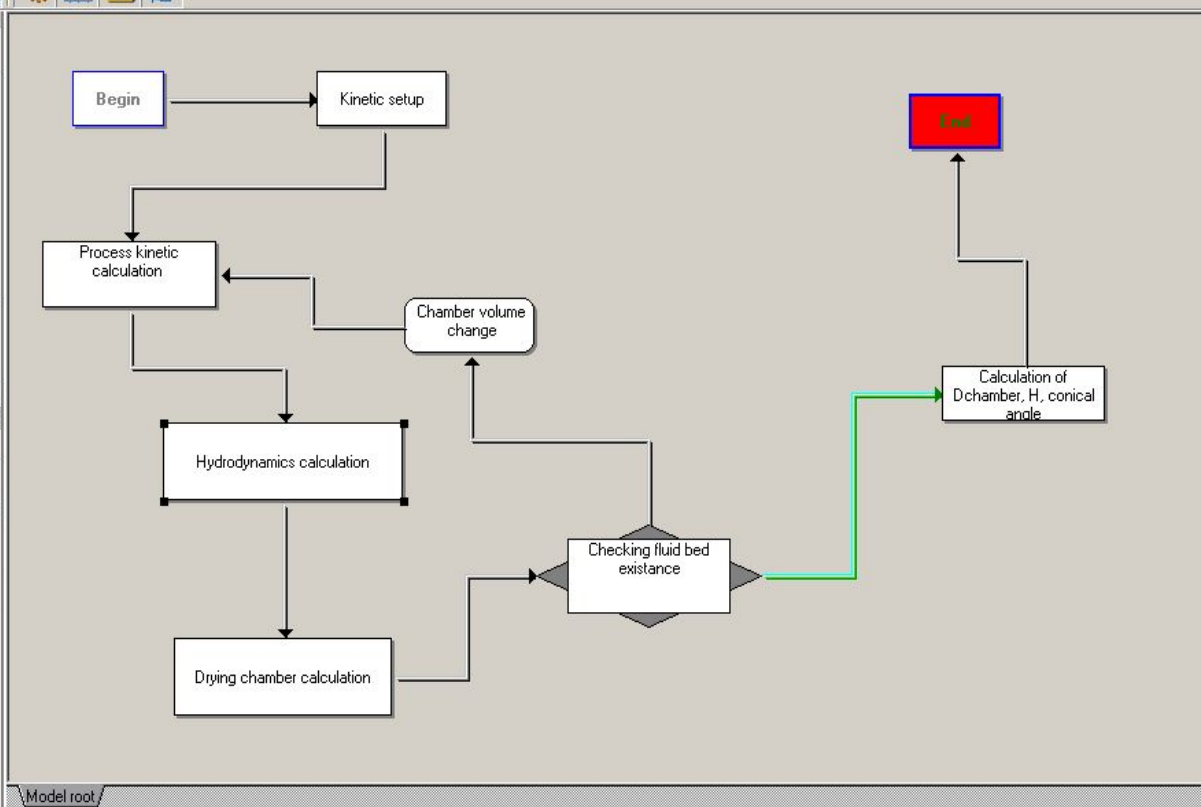


Переменная	Значение





Property	Value
Default transition	StateNode3
Caption	Hydrodynamics calculation
Element name	StateNode2
Element code	



Variable	Value
iter	7
g	9.81
tu	1.5
c	1042
v	2.27E-5
ro	1.395
eps1	0.7
a	3.11E-5
lambda	0.0306
u	7.5
d	0.0052
dmax	0.001
psi	0.8
ro1	1073
Ga	0.3
hsl	0.6
u1	1.01
u2	1.59
u3	2.16
u4	2.74
u5	3.32
u6	3.89
t1	200
t2	160
t3	120
t4	110

StateNode1:Invalid parameters, function GETFROMMVS : " is not  
 StateNode2:Invalid parameters, function GETFROMMVS : " is not

File

Parameters

- Lock
- Grid
- Grid 2
- Legend

Control

View

Align

Reset

Mode



# Parametrical drawings module

Модуль параметризации

Файл Модель Помощь

Диаметр 10

Радиус 35

300

300

110

А А

В В

Название переменной

Введите название переменной

Var1

OK Cancel

Dim. 1 [-773.32, -45.56] Zoom: 0.59

Переменные	Переменн...	Значение
	d1	140
	h1	100
	h2	290
	d2	300
	h3	450
	h4	20
	h5	100
	d3	10
	l	15
	d4	70
	Var1	0

Описание модели

```

Rect. d11: X1=-d1/2-10; Y1=0; X2=d1/2+10; Y2=-6;
Rect. d12: X1=-d1/2-10; Y1=-5; X2=d1/2+10; Y2=-10;
Polygon. c11: BClr=Black; BSt1=BDiagonal; X1=-d1/2+10; Y1=0; X2=-d1/2-20; Y2=h1; X3=-d1/2-25; Y3=h1; X4=
Polygon. c12: BClr=Black; BSt1=BDiagonal; X1=d1/2-10; Y1=0; X2=d1/2+20; Y2=h1; X3=d1/2+25; Y3=h1; X4=d1/2+
Rect. d13: X1=-d1/2-35; Y1=h1+6; X2=d1/2+35; Y2=h1;
Rect. d14: X1=-d1/2-35; Y1=h1+10; X2=d1/2+35; Y2=h1+5;
Polygon. c21: BClr=Black; BSt1=BDiagonal; X1=-d1/2-20; Y1=h1+10; X2=-d2/2+10; Y2=h1+10+h2; X3=-d2/2+5;
Polygon. c22: BClr=Black; BSt1=BDiagonal; X1=d1/2+20; Y1=h1+10; X2=d2/2-10; Y2=h1+10+h2; X3=d2/2-5; Y3=
Rect. s3: X1=(d2-d1)/4+d1/2-15; Y1=2*(h1+h2)/3+10-25; X2=(d2-d1)/4+d1/2+25; Y2=2*(h1+h2)/3+10-35;
Rect. s4: X1=(d2-d1)/4+d1/2+24; Y1=2*(h1+h2)/3+10-15; X2=(d2-d1)/4+d1/2+32; Y2=2*(h1+h2)/3+10-45;
Rect. d15: X1=-d2/2-5; Y1=h1+h2+15; X2=d2/2+5; Y2=h1+h2+8.5;
Rect. d16: X1=-d2/2-5; Y1=h1+h2+21; X2=d2/2+5; Y2=h1+h2+14;
Polyline. f11: X1=-d2/2+5; Y1=h1+h2+h3+24; X2=-d2/2+5; Y2=h1+h2+21; X3=-d2/2+10; Y3=h1+h2+21; X4=-d2/2+
Polyline. f12: X1=d2/2-5; Y1=h1+h2+h3+25; X2=d2/2-5; Y2=h1+h2+21; X3=d2/2-10; Y3=h1+h2+21; X4=d2/2-10;
arc. 6: BSt1=Clear; X1=0; Y1=0; X2=h1+h2+h3+20+h4; Y2=0; X3=d2/2-5; Y3=h1+h2+h3+20; X4=-d2/2+5; Y4=h1+h2+
arc. 7: BSt1=Clear; X1=0; Y1=0; X2=h1+h2+h3+20+h4-5; Y2=0; X3=d2/2-10; Y3=h1+h2+h3+20; X4=-d2/2+9; Y4=h1+h2+
Rect. s1: X1=-6; Y1=h1+h2+h3+20+h4+26; X2=6; Y2=h1+h2+h3+10+h4;
Rect. s2: X1=-10; Y1=h1+h2+h3+20+h4+30; X2=10; Y2=h1+h2+h3+20+h4+25;
Rect. f13: BSt1=Clear; X1=-d2/2+10; Y1=h1+h2+30; X2=d2/2-9; Y2=h1+h2+20;
Polyline. f17: PSt1=Dot; X1=-d2/2+15; Y1=h1+h2+20; X2=4*(-d2/2+20)/5; Y2=h1+h2+20; X3=4*(-d2/2+20)/5;
    
```

Ошибки

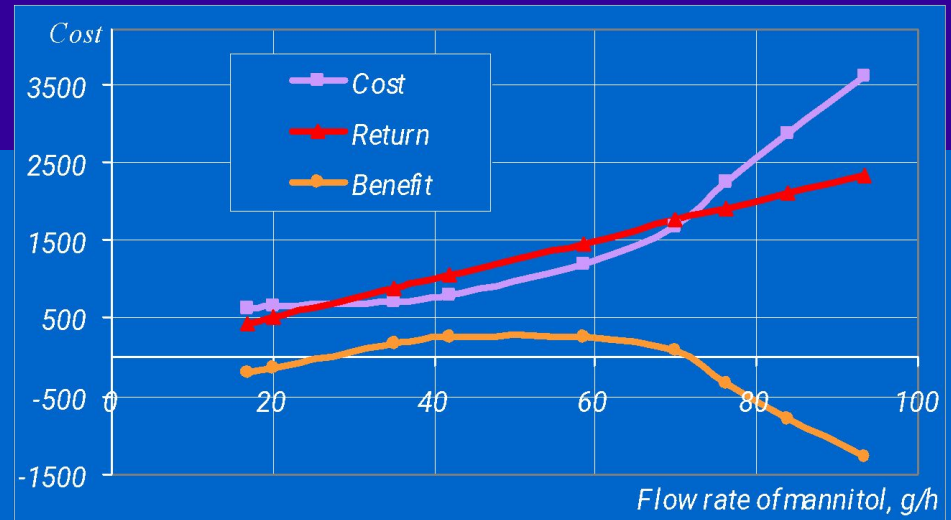
Добавить Удалить

# Optimization

Benefit = Return - Cost

Cost = f (Price<sub>Raw m.</sub>, Price<sub>Air</sub>)

Price<sub>Air</sub> = f (Energy)



<i>Air velocity, m/sec</i>	<i>Flow rate, g/h</i>	<i>Return, \$</i>	<i>Cost, \$</i>	<i>Benefit, \$</i>
0,844	93,36	2334,00	3010,00	-676,00
0,719	84,00	2100,00	2564,45	-464,45
0,594	76,38	1909,50	2118,57	-209,07
0,469	70,02	1750,50	1671,92	78,58
0,344	58,50	1462,50	1227,04	235,46
0,219	42,00	1050,00	782,45	267,55
0,119	35,00	875,00	670,00	205,00
0,100	20,00	500,00	600,00	-100,00

- 
- 
- 

# Contact information

Visit Web-page at <http://stop.at/dryinf/>  
for more information and demo download.

For getting this software, please mail to:

[chemcom@muctr.edu.ru](mailto:chemcom@muctr.edu.ru)