PRADIS

REFERENCE BOOK ON THE MODELS
MODULE HYDRO

THE SOFTWARE FOR SIMULATION OF NON-STATIONARY PROCESSES IN MECHANICAL SYSTEMS AND SYSTEMS OF OTHER PHYSICAL NATURE

VERSION 4.3

Contents

1. The hydraulic models

1.1. AGG - Gas-hydraulic storage battery

Storage battery, gas-hydraulic without the indication of the method of the separation of environment taking into account state of the gas about the polytropic law

DEGREES OF FREEDOM:
1 pressure at the point of the connection

PARAMETERS:
1 - total volume of storage battery, m ** 3 (VA>0)
- the volume of gas with the charging, m ** 3 (VZ>0 and VZ<VA)
* 3 - the kinematic viscosity of liquid with the atmospheric pressure and to temperature 50 degreeC, cSt (NU0>0)
* 4 - density of liquid with the atmospheric pressure and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
the modulus of elasticity of liquid with the atmospheric pressure and to temperature 20 degreeC, MPa (E0>0)
* 6 - piezocoefficient the exponential dependence viscosity from the pressure, 1/MPa (MNU>=0)
7 - constant of proportionality of the modulus of elasticity liquid from the pressure, 1/MPa (ME>0)
it is eighth the relative gas content of the liquid with the atmospheric pressure (VG0>=0)
9 - polytropic exponent of process (N>=1 I Of n<=1.5)
* 10 - heat coefficient the exponential dependence viscosity from the pressure, 1/degreeC (SNU>=0)
11- volumetric expansion coefficient of liquid, 1/degreeC (ALF>=0)
12- temperature of liquid, degreeC (TG>0, TG<200)
13- initial pressure before the storage battery (P0>-0.1)

NOTESymbol * noted the parameters, in this model not Symbol * noted the parameters, before this model not
using. They are introduced for the uniformity of the description the properties of liquid before all hydraulic analogs.

ELEMENTS OF THE WORKING VECTOR:
1 - the instantaneous value of the volume of gas before the storage battery
the reduced volume
3- the initial value of the relative volume of gas in accumulator.

SPECIAL SITUATIONS:
If during the 1st steps of integration in the storage accumulator there is no liquid, then the emergency halt occurs

1.2. CLPDG - Piston hydraulic cylinder of the double-sided action

Hydraulic cylinder of the piston of the double-sided action

FIELD OF APPLICATION: Hydraulic drive

DEGREES OF FREEDOM:
1 - pressure in 1 cavity
it is 2nd pressure in 2 cavities
3- progressive of the piston
4 - progressive of the housing

PARAMETERS:

SIGNIFICANT DIMENSIONS

1 - diameter of piston, m (DP>0)
is 2nd the diameter of stock 1 of cavity, m (DS1>=0, DS1<DP)
3- diameter of the stock of 2 cavities, m (DS2>=0, DS2<DP)
4 - thickness of the walls of cylinder, m (DEL>0)

CHARACTERISTICS OF THE PACKINGS

it is 5th frictional force before the packings in the absence (FT0>=0)
pressure before cavities, N
6 - constant of proportionality of frictional force (KF1>=0)
from pressure in 1 cavity, m ** 2
7- constant of proportionality of frictional force (KF2>=0)
from pressure in 2 cavities, m ** 2
is eighth leakage coefficient through piston packings (GUT>=0)
l/(MPa*min)

OTHER CHARACTERISTICS OF THE CYLINDER

9 - dead space 1 of cavity, m ** 3 (VMS1>0)
10 - dead space 2 cavity, m ** 3 (VMS2>0)
11- mass of piston, kgf (MP>0)
12- mass of housing, kgf (MK>0)
13- modulus of elasticity of 1 types of the walls
cylinder (Young's modulus), pA (EC>0)
14 - condition of the presence of the force of gravity (NG = 0 or 1)
15- stiffness of supports, N/m (CU>1e6 of <1e11)

PROPERTIES OF THE LIQUID

16- kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
17- density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
18- modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
19 -piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
20- constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)

21 - the relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
22- polytropic exponent of the process (N>=1 I of <=1.5)
23- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
24 - the volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
25 - the temperature of liquid, degreeC (TG>0, TG<200)

INITIAL CONDITIONS

26 - initial distance from the piston to
cover 1 of cavity, m (XS10>0)
27 - initial distance from the piston to
the cover of 2 cavities, m (XS20>0)
28 - the direction of piston stroke during the supplying
liquid beside 1 cavity (IP=+1, 0, -1)

ELEMENTS OF STATE VECTOR:
1 -deformation of the packings

ELEMENTS OF THE WORKING VECTOR:
1 -area of 1st cavity
of 2nd the cavity
3- piston clearance
4 - coefficient of the account of the given modulus of elasticity
area of the 1st stock
6 - area of the 2nd stock
7 - minimum is the preliminary displacement of the packings
it is eighth the shear stiffness of packings

1.3. KDG - The hydraulic valve of pressure

NAME: The hydraulic valve of the pressure
with the static expense
by the characteristic

FIELD OF APPLICATION: Hydraulic drive

DEGREES OF FREEDOM:
1 - pressure in the applied hydraulic-main
pressure in the branch hydraulic-main

PARAMETERS:
1 - the internal diameter, m (D>0)
it is 2nd the pressure of adjustment, MPa (PN>0)
3- the expenditure of adjustment, l/min (QN>0)
4 - loss factor before that opened
state, l/(MPa*min) (KP>0)
is 5th the leakage coefficient, l/(MPa*min) (KU>0)
6 - kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
7 - density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
9 - piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
10 - constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
11- relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
12- polytropic exponent of process (N>=1 I Of n<=1.5)
13- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
14 -volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
15- temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1 -Reynolds number

ELEMENTS OF THE WORKING VECTOR:
1 -the wetted perimeter
it is 2nd the constant of the correction
3- coefficient before the discharge characteristic
4 - flow passage cross-sectional area
the exemplary volume of liquid in the valve

1.4. RG32 - Distributer is trilinear two-position

NAME: Distributer is trilinear two-position
with the linear law of variation in the passage
section from the drive signal

FIELD OF APPLICATION: Hydrodynamics

DEGREES OF FREEDOM:
1 pressure at 1 point of connection (entrance)
it is 2nd pressure at 2 points of connection (output 1)
3- pressure at 3 points of connection (output 2)
4 value 1 the drive signals
it is 5th the value 2 the drive signals

PARAMETERS:
1 the internal diameter, m (D>0)
coefficient of discharge before the completely open state is 2nd
with the developed turbulent flow conditions
(MDT>0)
MDT=1/sqrt (KSI), where KSI - coefficient of resist.
in the case of the presence of the hydraulic tests
MDT=Q/S*sqrt (RO/2/dp)
3- the coefficient of overflows, l/(MPa*min) (KU>0)
4 value of the disagreement of control signals,
shifting distributer from the regime
the connection of lines 1-> 2 beside the regime
the connection of lines 1-> Oe (DUMAX>0)
it is 5th the kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
6 density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
7 modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
piezocoefficient the exponential dependence is eighth
viscosity from the pressure, 1/MPa (MNU>=0)
9 constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
10 relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
11- polytropic exponent of process (N>=1 I Of n<=1.5)
12- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
13- volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
14 temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1,2 - Reynolds number before the lines

ELEMENTS OF THE WORKING VECTOR:

1 the wetted perimeter

it is 2nd the constant of the correction

3- a critical pressure differential

4 flow passage cross-sectional area

1.5. QTR - Source of the expenditure of the trapeziform form

Source of the expenditure of trapeziform form.
NAME: Source of the expenditure
changing about the trapeziform law.

FIELD OF APPLICATION : Hydraulics

DEGREES OF FREEDOM:
1 pressure at the point of the connection

PARAMETERS:
1 the initial level;
it is 2nd the maximum value, undertaken with its sign
(ordinate of the gently sloping section of trapezoid);
3- the moment of the beginning of the change;
4 duration of the initial section of the change;
it is 5th the duration of gently sloping section with the constant
by the value;
6 duration of the finite segment of change.

1.6. TRGT - The hydraulic line, turbulent

The hydraulic line, turbulent
NAME: Conduit is hydraulic,
with the turbulent flow conditions of the liquid
taking into account the inertia and elastic properties
the liquid

FIELD OF APPLICATION: Hydrodynamics

DEGREES OF FREEDOM:
1 pressure at 1 point of the connection
it is 2nd pressure at 2 points of the connection
before the model there are 2 auxiliary
internal of the unit

PARAMETERS:
1 length of conduit, m (L>0)
are 2nd internalizations diameter, m (D>0)
3- the thickness of wall, m (DELT>0)
4 equivalent roughness, m (DELE>0)
is 5th the modulus of elasticity of conduit, pA (ET>1E6)
6 kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
7 density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
the modulus of elasticity of liquid with the atmospheric pressure is eighth
and to temperature 20 degreeC, MPa (E0>0)
9 piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
10 constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
11- relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
12- polytropic exponent of process (N>=1 I Of n<=1.5)
13- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
14 volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
15- temperature of liquid, degreeC (TG>0, TG<200)
16 initial pressure before the conduit (P0>-0.1)

ELEMENTS OF STATE VECTOR:
1,2 - Reynolds number in parts the tube

ELEMENTS OF THE WORKING VECTOR:
1 critical pressure differential
it is 2nd critical Reynolds number
3- the area of the flow

1.7. RG22- Distributer is bilinear two-position

Distributer is bilinear two-position

NAME: Distributer is bilinear two-position
with the linear law of variation in the passage
section from the drive signal

FIELD OF APPLICATION: Hydrodynamics

DEGREES OF FREEDOM:
1 pressure at 1 point of the connection
it is 2nd pressure at 2 points of the connection
3- the value 1 the drive signals
4 value 2 the drive signals

PARAMETERS:
1 the internal diameter, m (D>0)
coefficient of discharge before the completely open state is 2nd
with the developed turbulent flow conditions
(MDT>0)
MDT=1/sqrt (KSI), where KSI - coefficient of resist.
in the case of the presence of the hydraulic tests
MDT=Q/S*sqrt (RO/2/dp)
3- the coefficient of overflows, l/(MPa*min) (KU>0)
4 value of the disagreement of control signals,
shifting distributer from that completely closed
state in that completely opened (DUMAX>0)
it is 5th the kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
6 density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
7 modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
piezocoefficient the exponential dependence is eighth
viscosity from the pressure, 1/MPa (MNU>=0)
9 constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
10 relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
11- polytropic exponent of process (N>=1 I Of n<=1.5)
12- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
13- volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
14 temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1 Reynolds number

ELEMENTS OF THE WORKING VECTOR:
1 the wetted perimeter

it is 2nd the constant of the correction
3- a critical pressure differential
4 flow passage cross-sectional area

1.8. NASG - Pump is hydraulic

Pump is hydraulic
NAME: Hydraulic pump
with the static characteristic

FIELD OF APPLICATION: Hydraulic drive

DEGREES OF FREEDOM:
1 rotation of pump spindle
it is 2nd pressure against the entrance
3- pressure against the output

PARAMETERS:
1 working volume, cm ** 3 (VR>0)
is 2nd the nominal overfall of pressures, MPa (PN>0)
3- the nominal frequency of rotation, rpm (NN>0)
4 volumetric efficiency of pump (KPDO>0 <1)
is 5th overall efficiency of pump (KPD<KPDO)
6 moment of the inertia of the rotor of pump, kg*m ** 2 (JR>0)
7 kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
it is eighth the density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
9 modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
10 piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
11- constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
12- relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
13- polytropic exponent of process (N>=1 I Of n<=1.5)
14 heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
15- volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
16 temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF THE WORKING VECTOR:
1 VM the given working volume
is 2nd KM the factor of mechanical losses
3- KG the factor of hydraulic losses
4 VW the supply of pump the l/rad
The V approximate volume of liquid before the pump is 5th

1.9. KPG - Guiding 2d, impedimental. to rotation around the axis of movement

Valve is protective hydraulic
NAME: Hydraulic safety valve
with the static expense
by the characteristic

FIELD OF APPLICATION: Hydraulic drive

DEGREES OF FREEDOM:
1 pressure before the applied hydraulic-main
it is 2nd pressure before the branch main

PARAMETERS:
1 the internal diameter, m (D>0)
it is 2nd the pressure of adjustment, MPa (PN>0)
3- minimum expenditure, l/min (QMIN>0)
4 loss factor before that opened
state, l/(MPa*min) (KP>0)
is 5th the leakage coefficient, l/(MPa*min) (KU>0)
6 kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
7 density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
the modulus of elasticity of liquid with the atmospheric pressure is eighth
and to temperature 20 degreeC, MPa (E0>0)
9 piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
10 constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
11- relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
12- polytropic exponent of process (N>=1 I Of n<=1.5)
13- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
14 volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
15- temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1 Reynolds number

ELEMENTS OF THE WORKING VECTOR:
1 the wetted perimeter
it is 2nd the constant of the correction
3- coefficient before the discharge characteristic
4 flow passage cross-sectional area
is 5th the exemplary volume of liquid before the valve 3- the given coefficient of the friction

1.10. KOG - Valve is reverse hydraulic

Valve is reverse hydraulic
NAME: Hydraulic check valve
with the static expense
by the characteristic

FIELD OF APPLICATION: Hydraulic drive

DEGREES OF FREEDOM:
1 pressure against the entrance
it is 2nd pressure against the output

PARAMETERS:
1 the internal diameter, m (D>0)
it is 2nd the pressure of opening, MPa (POT>0)
3- coefficient of discharge with the developed turbulent
flow conditions (MDT>0)
MDT=1/sqrt (KSI), where KSI - coefficient of resist.
in the case of the presence of the hydraulic tests
MDT=Q/S*sqrt (RO/2/dp)
4 leakage coefficient, l/(MPa*min) (KU>0)
it is 5th the kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
6 density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
7 modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
piezocoefficient the exponential dependence is eighth
viscosity from the pressure, 1/MPa (MNU>=0)
9 constant of proportionality of the modulus of elasticity
liquid from the pressure, 1/MPa (ME>0)
10 relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
11- polytropic exponent of process (N>=1 I Of n<=1.5)
12- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
13- volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
14 temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1 Reynolds number

ELEMENTS OF THE WORKING VECTOR:
1 the wetted perimeter
it is 2nd the constant of the correction
3- a critical pressure differential
4 flow passage cross-sectional area

1.11. DRG - Choke is hydraulic

Choke is hydraulic
NAME: Hydraulic choke
with the constant flow area
and by the symmetrical characteristic

FIELD OF APPLICATION: Hydrodynamics

DEGREES OF FREEDOM:
1 pressure at 1 point of the connection
it is 2nd pressure at 2 points of the connection

PARAMETERS:
1 the internal diameter, m (D>0)
coefficient of discharge with the developed turbulent is 2nd
flow conditions with the flow of 1->2 (MDT1>0)
MDT=1/sqrt (KSI), where KSI - coefficient of resist.
in the case of the presence of the hydraulic tests
MDT=Q/S*sqrt (RO/2/dp)
3- coefficient of discharge with the developed turbulent
flow conditions with the flow of 2->1 (MDT2>0)
4 kinematic viscosity of liquid with the atmospheric
pressure and to temperature 50 degreeC, cSt (NU0>0)
it is 5th the density of liquid with the atmospheric pressure
and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
6 modulus of elasticity of liquid with the atmospheric pressure
and to temperature 20 degreeC, MPa (E0>0)
7 piezocoefficient the exponential dependence
viscosity from the pressure, 1/MPa (MNU>=0)
the constant of proportionality of the modulus of elasticity is eighth
liquid from the pressure, 1/MPa (ME>0)
9 relative gas content of the liquid
with the atmospheric pressure (VG0>=0)
10 polytropic exponent of process (N>=1 I Of n<=1.5)
11- heat coefficient the exponential dependence
viscosity from the pressure, 1/degreeC (SNU>=0)
12- volumetric expansion coefficient of liquid,
1/degreeC (ALF>=0)
13- temperature of liquid, degreeC (TG>0, TG<200)

ELEMENTS OF STATE VECTOR:
1 Reynolds number

ELEMENTS OF THE WORKING VECTOR:
1 the wetted perimeter
it is 2nd the constant of the correction
3- a critical pressure differential
4 flow passage cross-sectional area

1.12. CG - Hydraulic capacity of the constant volume

Hydraulic capacity of the constant volume
NAME: Hydraulic capacity of the constant volume
taking into account the gas content of the liquid

FIELD OF APPLICATION: Hydrodynamics

DEGREES OF FREEDOM:
1 pressure at the point of the connection

PARAMETERS:
1 volume of capacity, m ** 3 (VG>0)
* it is 2nd the kinematic viscosity of liquid with the atmospheric pressure and to temperature 50 degreeC, cSt (NU0>0)
* 3- the density of liquid with the atmospheric pressure and to temperature 20 degreeC, kG/m ** 3 (RO0>0)
4 modulus of elasticity of liquid with the atmospheric pressure and to temperature 20 degreeC, MPa (E0>0)
* is 5th piezocoefficient the exponential dependence viscosity from the pressure, 1/MPa (MNU>=0)
6 constant of proportionality of the modulus of elasticity liquid from the pressure, 1/MPa (ME>0)
7 relative gas content of the liquid with the atmospheric pressure (VG0>=0)
is eighth the polytropic exponent of process (N>=1 I Of n<=1.5)
* 9 heat coefficient the exponential dependence viscosity from the pressure, 1/degreeC (SNU>=0)
10 volumetric expansion coefficient of liquid, 1/degreeC (ALF>=0)
11- temperature of liquid, degreeC (TG>0, TG<200)
12- initial pressure (P0>-0.1)

NOTE: Symbol * noted the parameters, before this model not using. They are introduced for the uniformity of the description the properties of liquid before all hydraulic analogs.

ELEMENTS OF THE WORKING VECTOR:
1 the reduced volume