## Contents

Foreword	1
1. Introduction and guide to the text	4
2. Methods of solution of differential equation systems for the purposes of dynamic	
systems simulation	11
equations	13
2.2 Implicit method with intermediate step	19
2.2.1. Algorithm of the implicit method with intermediate step	24
2.2.2 Evaluation of simulation precision	25
2.3.3. Conclusions concerning the implicit method with intermediate step	29
3. Methodology of building simulation models of large-scale dynamic systems	31
3.1. Subsystem and description	36
3.2. Decomposition method.  3.3. Solution of large-scale systems, when the graph of the interconnections of	40
subsystems is a tree	47
3.4. General remarks on the decomposition method	49
4. Pipeline gas transportation systems — basic concepts	53
4.1. Pipeline gases	54
4.2. Elements of pipeline networks	60
4.1. Pipeline gases	65
5. Mathematical description of gas flow through a pipeline	70
6. Frequency analysis and simplification of the description of nonstationary gas flow	-
through a mineline	80
6.1. Description of nonstationary flow by transfer functions	82
by transfer functions which are derived taking into account the influence	9
of both the inertia of the flowing gas and the pipeline section elevation .	83
6.1.2. Model of nonstationary flow of real gas in a pipeline section described by transfer functions of generally infinite order and derived using Bessel	
functions	96
6.1.3 Simplified model of nonstationary real gas flow through a pipeline sec-	
tion described by first-order transfer functions, derived from those in	109
6.1.2	

## Contents

6.1.4. Simplified model of nonstationary flow of real gas through a pipeline	
the dietribution of specific mass along the length	112
6.1.5. Numerical analysis of transfer parameters of models approximated by	123
at the dynamic properties of a model of Hollstationary gas	136
	137
- Converte frequency characteristics,	1.07
and the of feature of properties of the dynamic model of gar	141
through a pipeline section	141
7. Space discretization and description of the dynamics of gas flow through a pipeline	
7. Space discretization and description of the dynamics of space discre-	154
at the leation method for nonstationary now and choice of special	
	155
a 1 1 and for the description of the dynamics of But	900
a distribution of the state of	155
m	161
The state of the s	173
and the state of nonetationary gas now infough a pipeline in	
	181
C.C analysis to a model with absolute rathering	182
7.3.1. Application of frequency analysis to a model of the section for net-	
4 44-	188
7.4. Discussion of the precision of dynamic models in stationary states	191
7.4. Discussion of the precision of dynamic models in a ringline network	197
8. Algorithmization of the solution of nonstationary gas flow in a pipeline network	198
description of penavior	198
and the description	202
and a straight and all type elements	203
a to t Filmiter	205
0 1 2 2 Procesure GOVETHOT	206
	209
2 . 2 4 Compressor station with turbo-compressors	213
and a sing elements as I S-IVDC.	214
	214
- In the second administration of the second	216
0.2.2 Matrix energity	
the decomposition method	217
af the system into supsystems	218
of NIC type non-pipe elements	
8.3.2. Incorporation of NS-type non-pipe elements 8.4. Gas leakage following pipeline rupture	230
	235
9.2. Comparison of computed and measured time behaviour. 9.3. Examples of dynamic simulation in large-scale and looped networks	262
9.3. Examples of dynamic simulation in large-scale and tooped and 19.3.1. Natural gas network	262
9.3.2. City gas network	. 279
9.4 Destruction of a long-distance gas-transport pipeline	

10. Supplements
methods of solution
10.1.1. Equations of stationary gas flow through a pipeline section
10.1.2. Solution methods of the static network description
10.1.3. Description of some relationships for stationary gas flow in dimension- less variables
10.2. Concentration of inter-off-takes into network nodes
10.2.1. The simple inter-off-take case
10.2.2. The case of several inter-off-takes
10.2.3. Practical procedure
10.2.4. Application of the assignment rule
10.3. Characteristics of compressor stations with turbo-compressors
10.3.1. A simplified characteristic of the turbo-compressor
10.3.2. Nominal characteristic of the turbo-compressor
10.3.3. Computation of the compressor station characteristic
10.4. SIMONE — a universal program package for dynamic simulation of pipeline
networks
10.4.1. Illustrative examples
10.4.2. Error messages
Notation
References
Recommended literature
Index