Modeling measurement situation in intelligent information and measurement system to determine thermo-physical properties of materials

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Abstract. Definition of thermo-physical properties in different thermal conductivity ranges of solid materials causes the need to consider numerous affecting factors, to create an information environment and model the measurement situation in the operation of intelligent information and measurement system. The purpose of the study is to reduce the measurement error of thermo-physical properties in materials. This problem is relevant and important in the process of controlling the reference parameters of products at the manufacturers. A theoretical framework for modeling the measurement situation is developed. This includes a conceptual model for the formation of the measurement situation, and a model of the research object domain. A mathematical model of the measurement situation and the methodology of its development is created. The problem of selecting the type of measurement situation in the range of investigated materials in terms of thermal conductivity is solved. The risk calculation algorithm of forming a measurement situation in an intelligent information and measurement system for determining the thermo-physical properties of materials is developed.

Keywords: measurement situation, thermo-physical properties, intelligent measurement system, object domain, conceptual model

1. Introduction

Thermal properties of solid materials should conform strictly to the standard requirements in the State Standard for the manufacture of materials and products made of them. Thus, it is necessary to determine the thermo-physical properties of materials at the stages of their production and operation, in product manufacturing, and in the construction facilities.

Increasing the accuracy of thermo-physical measurements is a relevant and important task in determining the thermo-physical properties of materials such as thermal conductivity and thermal diffusivity coefficients using an intelligent information and measurement system (IIMS).

The article by Laghi, L., Pennecchi, F. and Raiteri, G., considers information and measurement systems that determine the thermo-physical properties of materials responsively, but with insufficient accuracy [1]. The articles [2, 3, 4, 5, 6, 7] describe information and measurement systems that are designed for rapid determination of the thermo-physical properties of materials and products. Artificial
intelligent technology is widely used in the systems. Famous foreign scientists D. Hoffman, L. Finkelstein, who are the founders of intelligent measurements and systems, presented scientific works [8,9] on the application of artificial intelligence methods in information and measurement systems. However, the works do not discuss methods of improving the accuracy of intelligent measurement systems. In the scientific works of [10] Russian scientists V. I. Tsvetkova, G.G. Rannev, D.V. Gaskarova the structure and operation principle of intelligent information systems and measurement tools are outlined. The analysis of the publications on the measurement systems shows that the considered systems are characterized by low speed response and accuracy in controlling the determined characteristics of the studied objects, given the impact of external and internal factors. The above defines the purpose of this work, that is to reduce the measurement error in determining the thermo-physical properties of materials in an intelligent information and measurement system.

2. Problem statement
The objective of the study predetermines modeling the measurement situation, which requires the solution of a certain set of problems.

The first problem is to build a conceptual model of forming a measurement situation in thermo-physical measurements. The second problem is to form a model of the research object domain. The next one is to develop a mathematical model of the measurement situation. Another problem is to create a methodology for developing a measurement situation. In addition, it is necessary to solve the problem of selecting the type of measurement situation to comply with the range of investigated materials in terms of thermal conductivity.

Then the development of an algorithm for calculating the risk of forming a measurement situation is required.

The last problem is to create the structure of materials TPP IIMS with modules of formation and control over the measurement situation.

3. Theory
A theoretical basis for modeling the measurement situation in the intelligent information and measurement system to determine the thermo-physical properties of materials is developed.

The conceptual model of the measurement situation can be represented as the following tuple:

\[ CM = < MIM, MMTM, MPM, MMP, MIS, MDF >, \]

where MIM is the model of investigated materials; MMTM is the mathematical model of thermo-physical measurement; MAM is the model of applied method for determining thermo-physical properties of materials; MRP is the model of mode parameters for thermo-physical measurement depending on measurement situation; MIS is the model of information situation, which reflects a set of information data necessary for implementing measurement situation in IIMS; MDF is the model of destabilizing factors, which affect the measurement subsystem in TPP IIMS of materials.

An important stage in the formation of a measurement situation is to establish the types of measurement situations for thermo-physical measurements that correspond to the appropriate range of thermal conductivity of the investigated materials: low - 0.02...0.2 W/MK; medium - 0.21...2 W/MK; high - 2.1...10 W/MK. At the same time, the set of indicators for each measurement situation is determined. According to the conceptual model the following indicators \((x_i)\) to reflect the main assignment of the components in the conceptual model are proposed: information on the thermo-physical properties, parameters and characteristics of the investigated materials \((x_m)\); levels of input and output signals of the components in the measurement subsystem of TPP IIMS of materials \((x_i)\); theoretical justification of the applied method to determine the parameters of thermo-physical properties of materials, namely, thermal conductivity \(\lambda\) and thermal diffusivity coefficients \(\alpha\) \((x_i)\); information about the mode parameters of implementation according to the type of measurement
situation \((x_i)\), data for implementing the measurement situation \((x_d)\), information about the destabilizing factors \((x_f)\). This implies that each type of measurement situation has a corresponding set of indicators \(x = (x_m, x_i, x_x, x_d, x_f)\). Next, the analysis and evaluation of indicators \(x_v\), \(v \in \{m, s, t, i, d, f\}\) are performed in order to assign to the range \(x_v\) of thermal conductivity of the investigated materials: low \((x_v^l)\), medium \((x_v^m)\) and high \((x_v^h)\).

Following the above, the corresponding types of measurement situations are distinguished:

1. The measurement situation \(S_l\), characterized by a set of indicators in making thermo-physical measurements for materials of low thermal conductivity range:
   \[
   \left( x_m^l, x_i^l, x_x^l, x_d^l, x_f^l \cup x_y^l \cup x_z^l \right); \quad (1)
   \]

2. The measurement situation \(S_m\) characterized by a set of indicators in measuring thermo-physical properties for materials of the medium range of thermal conductivity:
   \[
   \left( x_m^m, x_i^m, x_x^m, x_d^m, x_f^m \cup x_y^m \cup x_z^m \right); \quad (2)
   \]

3. The measurement situation \(S_h\), corresponding to the set of indicators for determining the parameters of the thermo-physical properties of materials of high thermal conductivity range:
   \[
   \left( x_h^h, x_i^h, x_x^h, x_d^h \cup x_y^h \cup x_z^h \right); \quad (3)
   \]

The presented measurement situations \(S_l, S_m, S_h\) (1) - (3) are used to form the model of a measurement situation, the structure of the intelligent information-measurement system of TPP materials and the algorithm for reconfiguration of the structural components of the system depending on the type of a measurement situation. This contributes to reduction of measurement error in determining the thermo-physical properties of the investigated materials.

The life cycle of forming the measurement situation includes many elements that make up the model of the research object domain in this study. A tuple of structural elements represents the model of the object domain \(M_{OD}\):
\[
M_{OD} = \langle U_{MS}, U_{SC}, U_{SS}, U_{DM}, U_{KDB}, U_{RI}, U_L \rangle, \quad (4)
\]
where \(U_{MS}\) is the set of elements of measurement situation (for control, measurement and calibration of intellectual information and measurement system); \(U_{SC}\) is the set of structural components of the TFS IIMS of materials, which realize the measurement situation; \(U_{SS}\) is the set of modules in IIMS, which perform various types of support in the system (software, algorithmic, methodological, metrological); \(U_{DM}\) is the set of decision-making operations in the IIMS based on a pattern recognition under uncertainty of a measurement situation; \(U_{KDB}\) is the set of elements of knowledge and data base models with information links to the represented models; \(U_{RI}\) is the set of information to establish the reliability of the information used in forming the measurement situation; \(U_L\) is the set of links used to exchange information in the models.

A mathematical model of the measurement situation \(M_{ms}\) is developed as a tuple of the following sets:
\[
M_{MS} = \langle V_i, V_c, V_m, V_p, V_x, V_d, V_e, V_c, \mu_{ms} \rangle, \quad (5)
\]
where \(V_i\) is the set of types of measurement situations; \(V_c\) is the set of degrees for the certainty of information (deterministic, fuzzy, uncertain); \(V_m\) is the set of information on measurement situations
for determining the thermo-physical properties for materials of the corresponding range of thermal conductivity (using intelligent measurement probes with linear, circular and flat heaters in implementing thermal effect on the investigated material to conduct thermal measurements of low, medium and high thermal conductivity; \( V_p \) is the set of mode parameters of thermo-physical measurements (power of thermal effect, duration of generated thermal pulses, time of measurements); \( V_{ch} \) is the set of characteristics of measurement situation (accuracy of mode parameters, methodical error, error of measuring probe); \( V_d \) is the set of data about reliability of applied information in measurement situations; \( V_e \) is the set reflecting the conformity of measurement situations to the range of thermal conductivity of the investigated materials (low, medium, high); \( \mu_{in} \) is the set responsible for the formation and control of measurement situations using electronic devices of the IIMS structural components; \( \mu_{in} \) is the set of attribute functions for the corresponding measurement situation according to the range of thermal conductivity of the investigated material.

The model of the subject domain (4) serves as the basis for the development of the procedure to create the measurement situation when making thermo-physical measurements in the IIMS. The procedure for forming the measurement situation includes the following steps:

- a knowledge base with information support for thermo-physical measurements is created, which includes a number of modules used in the control, measurement and calibration of the intelligent information and measurement system of TFS materials;
- information from the knowledge base is selected according to the research object domain and measurement situations;
- information in knowledge and databases is updated according to the relevance and novelty of the information content;
- the structure of the measurement situation is developed, taking into account the modules and structural components of the intelligent information and measurement system of TFS materials for thermo-physical measurements;
- modules of measurement situations are created, the content of which should correspond to the algorithm for determining the thermo-physical properties of materials depending on the range of thermal conductivity of the investigated materials.

The solution to the problem of selecting the type and structure of the measurement situation is based on the developed mathematical models of the object domain (4) and the measurement situation (5), depending on the information data of the preliminary test thermo-physical measurements.

Stating the problem of selecting a measurement situation. A series of situational sets is formed: \( V_s = \{ V_t^c, V_t^m, V_t^{sc} \} \) is the set of applied types of measurement situations ( \( V_t^c \) – in controlling TFS materials, \( V_t^m \) – under the thermo-physical measurement in IIMS, \( V_t^{sc} \) – in performing system calibration); \( V_c = \{ V_c^{det}, V_c^{fuz}, V_c^{unc} \} \) – a set of degrees characterizing the certainty of information ( \( V_c^{det} \) – deterministic, \( V_c^{fuz} \) – fuzzy, \( V_c^{unc} \) – uncertain); \( V_{in} = \{ V_{in}^{nlh}, V_{in}^{nch}, V_{in}^{nh} \} \) is the set of information on implementation of measurement situations in determining TFP of materials using methods and measuring probes ( \( V_{in}^{nlh} \) – with linear, \( V_{in}^{nch} \) – with circular, and \( V_{in}^{nh} \) – flat heaters, respectively); \( V_p = \{ V_p^l, V_p^m, V_p^h \} \) is the set of mode parameters in thermo-physical measurements ( \( V_p^l, V_p^m, V_p^h \) are the mode parameters for materials of low, medium and high thermal conductivity, respectively); \( V_{ch} = \{ V_{ch}^{AP}, V_{ch}^{ME}, V_{ch}^{EP} \} \) is the set of characteristics of measurement situation ( \( V_{ch}^{AP} \) is the accuracy of mode parameters; \( V_{ch}^{ME} \) is the methodical error; \( V_{ch}^{EP} \) is the error of the measuring
probe); \( V_c = \{ V^l_c, V^m_c, V^h_c \} \) is the set reflecting the conformity of measurement situations to the range of thermal conductivity of the investigated materials (low, medium, high) \((V^l_c, V^m_c, V^h_c\) are low, medium, high thermal conductivity, respectively); \( V_{MS} = \{ V^{MS}_i, i = 1, ..., k_{MS} \} \) is the set of measurement situations used in the operation of the intelligent information and measurement system of TFS materials, \( V^{MS}_i \) is the \( i \) -th measurement situation.

The application of the Cartesian product of the given sets allows us to form the set of information environment \( H \), representing the measurement situation:

\[
H = V_t \times V_c \times V_{IN} \times V_p \times V_{ch} \times V_c \times V_{MS} = \\
\{ h_{j,n,m,l,c,d,i} : j \in \{c,m,sc\}; n \in \{det,fuz, unc\}; m \in \{mlh,mch,mfh\}; l \in \{1,m,h\}; c \in \{AP,ME,EP\} ; d \in \{MS,MS_{m},MS_{h}\} ; i = 1,...,k \}.
\]

The components of the \( h_{j,n,m,l,c,d,i} \) set \( H \) correspond to the measurement situation, and they are represented by a tuple:

\[
\| h_{j,n,m,l,c,d,i} \| = \{ V^l_c, V^m_c, V_{in}^m, V^l_p, V_{ch}^c, V^d_c, V^{MS}_i \}.
\]

Applying the data of the formed sets, the measurement situation is selected, which belongs to the information environment of the IIMS functioning when we determine the TFS of materials in the corresponding range of thermal conductivity \((V^{MS}_i \in V^{MS})\).

Solving the problem on the choice of a measurement situation in the set \( H \) we define \( k \) subsets \( H_i \), \( i = 1,...,k \), which correspond to one particular measurement situation. This approach creates a model "Information Environment - Measurement Situation", which is represented by product rules:

\[
\begin{align*}
\text{IF} & \ h_{j,n,m,l,c,d,i} \in H_i, \ \text{THEN use} \ V^{MS}_i, \\
\text{IF} & \ h_{j,n,m,l,c,d,i} \in H_k, \ \text{THEN use} \ IETM \ V^{MS}_k.
\end{align*}
\]

Solving the problem of selecting MS, in case of forming measurement situations with similar indicators from the created data sets of the information environment of the TPP IIMS of materials, then the problem of optimizing the variant of the measurement situation is solved with due account for the probabilities.

MS optimization problem statement: the model of the measurement situation structure as a tuple of sets of the information environment components is specified; the type and cost indexes of the formed measurement situation modules, \( V^\nu = \{ v_1^\nu, c_1^\nu, ..., v_k^\nu, c_k^\nu \} \), \( \nu \in \{c;m;cb\} \) are also specified, where \( v_i^\nu, c_i^\nu \) are the content and cost index of the \( i \) -th module \( \nu \) of the \( \nu \) -th device for the implementation of the IIMS functioning modes \((c – control, m – measurement, cb – calibration)\) with due account for material thermal conductivity; \( V_c \) is the conformity set of measurement situations to the range of thermal conductivity of the investigated materials; \( r_{ac} \) is the acceptable value of default probability of the functional assignment in the intelligent measurement system; the set specifying the operation modes of the IIMS of TPP materials:

\[
\nu = \{ v_1, v_2, ..., v_k \}.
\]

The criterion of optimality is the total additional costs of forming modules for different types of measurement situations, given the ranges of thermal conductivity of the investigated materials:

\[
Q = \sum_{i \in N_c} C^c_i + \sum_{i \in N_m} C^m_i + \sum_{i \in N_{cb}} C^cb_i.
\]
where \( N_c, N_m, N_{cb} \) are the sets of numbers for additional devices of the measurement situation modules, for the control, measurement, and calibration modules, respectively.

It is necessary to set the structure of the modules for the measurement situation

\[
V^* = \left\{ \left( v^c_i, i \in N_c \right), \left( v^m_i, i \in N_m \right), \left( v^{cb}_i, i \in N_{cb} \right) \right\},
\]

for which the restrictions are fulfilled on the probability \( r^p \) of default in various types of repairs within the scheduled time and the occurrence of operational failures (9) at the minimum total cost of implementing the measurement situation modules (criterion (7))

\[
r^p (N_c, N_m, N_{cb}) \leq r_{acp}.
\]

When solving this problem, the calculation of risks due to the impact of influencing factors is performed. We developed an algorithm for calculating the probability of a negative event. This algorithm provides for multiple modes of operation of the intelligent information and measurement system of TFS of \( H \) materials, taking into account the information environment, compliance of the measurement situations with the range of thermal conductivity of the investigated materials. The set \( H \) can be viewed as the Cartesian product of the sets \( c, m, cb \)

\[
V^* = \left\{ v^c_i, v^m_i, v^{cb}_i \right\}, \quad h_{c,m,cb,1} = \left\{ \left( v^c_i, v^m_i, v^{cb}_i \right) \right\}
\]

The algorithm uses a number of assumptions: the probability of negative events decreases as the number of auxiliary modules of measurement situation implementation increases. Auxiliary module and indicative module are determined as a result of test measurements in the IIMS of TFS materials. Based on the operating conditions of the IIMS, a redundant module of the measurement situation can be formed.

The algorithm for calculating the probabilities of negative events is as follows:

- The initial probability values \( P^e \) are estimated from the test measurements using the formula

\[
r_0 = 1 - P^e N^e \text{ and then the constraints (9) are checked.}
\]

A subset of oriented modules \( N^m_{cm} \subset N_c \) is formed, which are determined as a result of test thermo-physical measurements while taking into account \( P_c \left( N^e_c \right) \):

\[
P_c \left( N^e_c \right) = P^e + \left( 1 - P^e \right) \left[ 1 - \alpha \left| N^e_c \right| \right],
\]

where \( \alpha \) is the coefficient, determined by the method of expert evaluations.

- The constraints (9) are checked under the probability of \( P_c \left( N^e_c \right) \) :

\[
r_0 \left( N^e_c \right) = 1 - P_c \left( N^e_c \right) P^e_m \leq r_{acp}.
\]

- If constraint (11) is not satisfied, a subset of oriented modules \( N^m_{cm} \subset N_m \), which correspond to the test thermo-physical measurements, is created and the probability \( P_m \left( N^e_m \right) \) is calculated using a formula similar to (10):

\[
P_m \left( N^e_m \right) = P_m^e + \left( 1 - P_m^e \right) \left[ 1 - \beta \left| N^e_m \right| \right],
\]

where \( \beta \) is the coefficient, determined by the method of expert evaluations.

- The constraints (9) are checked under the probability of \( P_m \left( N^e_m \right) \) :

\[
r_0 \left( N^e_m, N^e_m \right) = 1 - P_c \left( N^e_m \right) P_m \left( N^e_m \right) \leq r_{acp}.
\]
If constraint (12) is not satisfied, a subset containing redundant modules should be formed:

\[ N^{ns}_c \subset N^e_c / N^{ec}_c. \]

Using \( N^{ns}_c \), a probability calculation is performed:

\[
P_c \left( N^{ec}_c \cup N^{ns}_c \right) = P_c \left( N^{ec}_c \right) + \left(1 - P_c \left( N^{ec}_c \right)\right) \left[ 1 - \exp \left( -\alpha_m \left| N^{ns}_c \right| \right) \right],
\]
a constraint check is performed:

\[
r \left( N^{ec}_c \cup N^{ns}_c, N^{ec}_m \right) = 1 - P_c \left( N^{ec}_c \cup N^{ns}_c \right) P_m \left( N^{ec}_m \right) \leq r_{acp}. \tag{13}
\]

If the constraint (13) is not satisfied, using the information of test thermo-physical measurements (6), a subset \( N^{ns}_m \subset N_c / N^{acp}_m \) is formed that takes into account the sets \( H \). These sets consider the operation modes of the IIMS of TPP materials based on the information environment data and the application of production rules.

The value \( N^{ns}_m \) is resulted from the probability calculation:

\[
P_m \left( N^{ec}_m \cup N^{ns}_m \right) = P_m \left( N^{ec}_m \right) + \left(1 - P_m \left( N^{ec}_m \right)\right) \left[ 1 - \exp \left( -\beta_m \left| N^{ns}_m \right| \right) \right].
\]

The calculated results of the probability assessment are used to select the type of a measurement situation when the intelligent information and measurement system of MTFS functions. The formed types of measurement situations are used in the IIMS of TFS materials. Its structural diagram is shown in Fig. 1.

The TPP IIMS of materials includes an intelligent device for processing the measurement information and a measurement subsystem. The principle of the IIMS operation using the description of measurement situations in the formalized form adapting to the range of investigated materials is as follows. An intelligent measuring probe with a microprocessor in the measuring chain provides the implementation of the applied methods for determining the thermo-physical properties of materials depending on the range of thermal conductivity of the investigated materials, namely, thermal insulation, construction, and composite materials. The linear heater method is used for materials with low thermal conductivity (0.02...0.2 W/MK); the circular heater method is for medium thermal conductivity (0.21...2 W/MK), and the flat heater method is employed for high thermal conductivity (2.1...10 W/MK). The probe initially performs a test measurement to form a measurement situation. It performs a thermal action on the investigated material and transmits the obtained measurement information from the temperature control sensors in the contact area of the probe and the investigated material through the components of the measurement channel (normalizing amplifier and analog-to-digital converter) to the measurement information-processing device with the appropriate algorithmic support and software. An intelligent microprocessor-based computing device performs processing and analysis of the measurement information and makes a decision on the choice of the measurement situation for the thermo-physical measurement in accordance with the range of the investigated material in terms of thermal conductivity. The decision is taken based on the use of algorithmic and software support of IIMS, knowledge base information and database, and the module of risk analysis.

The module of formation and control of the measurement information transmits information about the data of the formed measurement situation, providing for the influence of destabilizing factors, to the microprocessor of the intelligent measuring probe for conducting thermo-physical measurement in accordance with the range of thermal conductivity of the research object. The determined parameters of thermo-physical properties of materials \( P_{TPP} \) (thermal conductivity coefficient \( \lambda \) and thermal diffusivity \( \alpha \)) are shown on the display of the intelligent computing device.
Figure 1. IIMS structural scheme of TPP of materials with the module for the formation and control of the measurement situation (notation: IMDPD - the intelligent measurement data processing device, KB - knowledge base, DB - database, SW - software, AS - algorithmic support, RAM - risk analysis module, DMU - decision making unit, MGCMS - module for generating and controlling the measurement situation, MP - microprocessor, CD - control device, D - display, MCD - measuring and computing device, T_{PPM} - thermo-physical parameters of materials, MS - measuring subsystem, MC - measuring channel, IMP - intelligent measuring probe, DF - destabilizing factors, IM - investigated materials)

The intelligent information and measurement system of TFS materials implements an algorithm for selecting the measurement situation according to the range of thermal conductivity of the investigated materials based on the information of preliminary test thermo-physical measurements.

4. Experimental results
A mock-up of the intelligent information and measurement system of TFS materials with the modules of formation and control of the measurement situation was developed and manufactured. The investigated objects shown in Table 1 were chosen for the experimental studies of the IIMS MTFS mock-up in the range of thermal conductivity of 0.02...10.0 W/MK. The experiment organization included the following: a test measurement on a reference standard (polymethylmethacrylate), analysis of the results, calibration of the IIMS MTFS, and thermo-physical measurements on the investigated materials.

The results of calculation for relative errors in measurements of the thermo-physical properties of materials (thermal conductivity coefficient $\lambda$ and thermal diffusivity $\alpha$) using the data of thermo-physical measurements are presented in Table 1.
Table 1. Data from experimental studies of intelligent information and measurement system of the TFS of materials

| Research objects          | Reference data | Measured data | Measurement Errors |
|---------------------------|----------------|---------------|--------------------|
|                           | $\alpha \cdot 10^{-7}$, m²/s | $\lambda$, W/m-K | $\alpha \cdot 10^{-7}$, m²/s | $\lambda$, W/m-K | $\delta_\alpha$, % | $\delta_\lambda$, % |
| Mineral wool              | 3.93           | 0.04          | 3.84              | 0.041          | 2.29               | 2.5               |
| PolymethylMethacrylate    | 1.09           | 0.195         | 1.12              | 0.200          | 2.75               | 2.56              |
| Gas silicate              | 3.80           | 0.26          | 3.90              | 0.27           | 2.63               | 3.84              |
| Cement                    | 29.10          | 0.85          | 29.98             | 0.88           | 3.02               | 3.53              |
| Crystal Quartz            | 3.34           | 7.21          | 3.44              | 7.48           | 2.99               | 3.74              |

Analysis of experimental data and relative errors in determining the thermo-physical properties of materials (coefficients of thermal conductivity and thermal conductivity ($\alpha$ and $\lambda$)) shows that the relative errors of measurement results of the study objects are within 3-4%.

5. Results and discussion

A conceptual model of the formation of the measurement situation during thermo-physical measurements was constructed providing for the models of the investigated materials, thermo-physical measurement, and method for determining the TPP of materials, the mode parameters of thermo-physical measurements, the information situation, and the destabilizing factors. This will contribute to improving the accuracy of measurements.

The created model of the research object domain allows designing an intelligent information and measurement system to form the structural components for the implementation of the measurement situation function: control, measurement, calibration; modules in the IIMS, carrying out software, algorithmic, methodological, informational and metrological support.

The development of a mathematical model and methodology for the formation of a measurement situation, the structure of an intelligent information and measurement system of TPP materials and an algorithm for reconfiguring the structural components of the system depending on the type of measurement situation reduces measurement error in determining the thermo-physical properties of the investigated materials.

6. Conclusion

A theoretical basis for modeling the measurement situation was created. This enables us to determine the thermo-physical properties of the investigated materials using an intelligent information and measurement system that adapts to the range of thermal conductivity of the research objects.

The problem of selecting the type of the measurement situation from the possible types used in thermo-physical measurements based on sets is solved. These sets characterize the information environment of the IIMS TPP materials functioning such as information about methods of determining the TFS of materials, mode parameters of thermo-physical measurements, structural components of the measuring probe and IIMS MTPP to implement the measurement situations, and influencing factors. Each measurement situation is distinguished by its conformity to the range of the investigated materials in terms of thermal conductivity.

In the case of close indicators in creating a measurement situation, the problem of optimizing the variant of a measurement situation with regard to probabilities is solved. This solution is distinguished by the developed algorithm for calculating the risk of forming a measurement situation in an intelligent information and measurement system when determining the thermal properties of materials.
The structure of intelligent information and measurement system of thermo-physical properties of materials was developed. The structure implements the algorithm of measurement situation selection according to the range of thermal conductivity of investigated materials, and the modules of formation and control of a measurement situation distinguish it.

Simulation of the measurement situation in the intelligent information and measurement system of TPP of materials allows achieving the objective of the research, that is to reduce the relative measurement error in the parameters of the thermo-physical properties of materials to 3-4 %.

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