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SYSTEMS OF MECHANICAL UNITS

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FOREWORD

In the USSR at present, there are four different standards which define the systems of mechanical units in use and the units themselves: (OST 169, OST VKS 5858, OST VKS 6052, and OST VKS 6053. The new GOST (State All-Union Standards) Project being examined here was introduced by the Committee on Measurements and Measuring Instruments and was accepted by the All-Union Committee of Standards on 10 April 1947 as a project. Noting that the project is aimed at a unification of mechanical, thermal, and electromagnetic units, based on the new MKS system, the article emphasizes the rather irresolute changeover to the new system, and recommends within a short time, the complete abolition of the technical MKfS system, and the retention of the CGS system as an auxiliary one. The range of the units of the MKS system can be considerably expanded by employing metric prefixes, but the prefixes should not be included in the names of the basic units. The article also recommends changing the name for the unit of mass, the kilogram. Like the GOST project the article contain various controversial matters which should be discussed.

The abundance of existing systems of units complicates their use in practice. The OST 169 of 1928 (Absolute System of Mechanical Units, MTS) embraces units of force, work and energy, power and mechanical tension, correlates the MTS and CGS units, and gives a table for converting the mechanical units of a technical system into units of the absolute system for exact and approximate computations. The OST VKS 5858 of 1933 (mass, weight, density) establishes the alphabetical designations and dimensions, and also defines weight, the acceleration of free fall, density, and specific volume. The OST VKS 6052 of 1934

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establishes the names, designation, definitions, and relationships for units of force, work and energy, power and mechanical tension. The OST VKS 6053 of 1934, includes a definition of the system, the classification of established standards of the CGS, MTS, and MKS systems, the range of application of each system, and the units of measurement of the system. Thus, in these multiple standards, the same data is repeated frequently and is full of contradictions and inaccuracies. A unification of the systems of units and regions of mechanical, thermal, and electromagnetic phenomena is urgently needed.

The path of unification lies in the introduction of MKS units (meter, kilogram-mass, second) in the new GOST project.

General Outline of Project

The most essential part of the project is the MKS system. The name for the unit of force in this system is defined as the newton which equals 105 dynes. The unit of energy, the joule, opens the possibility of extending this system to thermal and electromagnetic phenomena.

The new project is not burdened with multiple or fractional units, in contrast to the former standards but tolerates necessary metric prefixes in a separate supplement consisting of four sections, making possible a wide diversity of the scales of units.

These features represent important achievements of the project and make it stand out as a valuable contribution toward orderliness in the mechanical units and in the unification of units generally. In accordance with the motives for unification, the MTS system is rightfully excluded from the project, but it is senseless to standardize three systems instead of one -- the MKS.

Thus, the project repeats two principal shortcomings which the previous standards contained, namely, a surplus of standardized systems and a double connotation of the term kilogram. This double connotation is an absurdity in the metrology of the 19th and 20th centuries.

The project introduces, somewhat hesitently, the new MKS system and does not emphasize its unification advantages over the other two systems, when, in fact, the next GOST should indicate clearly that the MKS system is a basis for the unification of unit systems in all fields of physics and must, therefore, replace all former unit systems, including the CGS system.

Classification of Unit Systems

How, then is the new system related to the former systems? K. M. Polivanov [1] points out four independent classification criteria for unit systems: (1) number of basic units, (2) systems of relationships, (3) dimensions whose units are accepted as basic, and (4) basic units. Polivanov calls the unit systems which have the same system of relationships holomorphic. The conversion between similar systems is not difficult. This is illustrated in individual cases, as well as in literature [2 and others]. All mechanical systems of units (CGS, MTS, MKS, technical, British) are holomorphic among themselves, since the relationships in mechanics are settled firmly and maintain an unchangeable form in all these systems. They also have the same number of basic units. Possible variations between systems of mechanical units result from criteria 3 and 4 mentioned above.

Selection of Basic Values

Two dimensions -- length (L) and time (T) -- are accepted in all basic physical unit systems. The third dimension -- mass (M) or force (F) -- is debatable. Consequently, there are two possible variations, LMT, or LFT. Great disputes arose in connection with the selection of one of these variations.

The first variation is represented in the project by two unit systems: CGS and MKS; and the second, the so-called technical system, by MKfS, i.e., meter, kilogram-force, second.

The former standards, as well as the new project, find the technical system the least acceptable and give preference to the LMT variations. But the former standards were more consistent: thus, OST/VKS 6052 tolerates only limited use of the technical system for computations of low accuracy and recommends the use of the CGS or MTS system in basic cases. The new project, electrically, admits both the LMT and LFT variations.

The unification of the unit systems, however, makes it obligatory for us to limit our selection to one of these two variations. The complex problem should be solved by taking into consideration the metrological data as well as the possibility of extending the unification to thermal and electromagnetic phenomena.

Metrologically, the unit of mass is undoubtedly more suitable, since the standard of mass is easier to establish by means of a definite weight. It is much more difficult to prepare and preserve a standard of force, due to this standard's dependency on secondary conditions, namely, on flexible constants of standard dynamometers, or on the gravity parameters of the given locality.

The energy unit of the MKS system -- the joule -- is already standardized, as is the unit of thermal and electrical energy [3]. Thus, the LMT system, i.e., the system of meter, kilogram-mass, second, reveals prospects for unification of the units in physics.

The selection of a dimension for the characteristic of the "quantity of a substance" is just as important. Quantities of identical chemical substances, at a constant temperature, can be compared by their volumes. However, the quantity of a substance is usually specified by weight. By the weight of a body changes according to gravity conditions; therefore, it is not an unalterable characteristic of the body. The change in weight of a body can reach 0.5 percent on the surface of the earth. A more reliable constancy at velocities well below the speed of light is possessed by the mass of bodies.

The mass of bodies is measured by one of the basic physicochemical instruments, the beam balance. Actually, transfer of the entire instrument into new gravitational conditions would change proportionally the weight of the balance and the measured body; therefore, the reading on the scale will not change. Thus, the word "weight" does not reflect any physical designation of the instrument. It should rather be called a "massometer."

Regardless of the unit system selected, the quantity of substance in a body should be specified neither by weight, nor by units of force, but by units of mass, i.e., in kilograms or grams. Such procedures are used, for example, in studying heat capacity.

It is true that the project introduces a new unit of mass for the technical system, the "inerta," which fills in the gaps of former standards not having a special name for the unit of mass in that system. The introduction of this unit discloses an important opportunity for specifying the quantity of a

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substance in inertas, the density in inertas/cubic meter, the thermal capacity in kilogravometers/inerta degree and so on. However, these units are so unusual that they will hardly be favored. The technical system is entirely unsuitable for other divisions of physics. One can imagine hwo unsuitable the coefficients would be in electrotechnical equations, if kilogravometer instead of joule became the unit of energy. The technical MKfS system cannot be generalized for allied sciences and has to be left as is.

Transition Period

It is possible that the sudden abolition of the technical system would not be advisable. It would be necessary then to point out in a future GOST the temporary nature of this system, a period of about 5 years. All new books and manuals would have to be published according to the new MKS system and the technical system would cease to exist altogether in 3 to 5 years.

However, here again we run into the previously mentioned double connotation of the term kilogram. This should not be tolerated even for a short time. The project, trying to eliminate this difficulty, takes the right course and introduces the term "kilograv" (kG) to replace the term kilogram-force. But no result has been achieved yet, and the double-connotation terminology may continue to exist.

Thus, kilogram-force is given as a basic term on the title page of the GOST project, and the footnote states that the word "force" can be omitted. Kilograv is listed only as a second term, in parentheses. This way the term kilogram stands for the measurement of force. The symbol kgf emphasizes this even more, since the letter "f," the first letter of the word "force" of the term kilogram-force, cannot in any way denote a part of the word kilograv.

The symbol kG is much better, since it can be related to the word kilograv. Besides, the symbol kG is already used and differs from the symbol kg.

Subsequent pages of the project also list the units, kilogram per square meter and kilogrammometer. As can be seen, nothing is left of kilograv; even the word "force" is omitted. Thus, the project brings us back to kilogram, the old double-connotation term.

The terms kilogram and kilogram-force should be eliminated from the technical system and the single term kilograv and its symbol kG (in Russian and Roman letters) should be adopted. Accordingly, the derived units should be named kilograv per square meter, kilogravometer, etc.

Multiple Systems of Units

Under the above term [L.4] we shall consider unit systems in which the basic dimensions coincide, but the scales of one or several basic units are selected from different systems (CGS and MTS). The derived units of multiple systems also differ (erg and kilojoule), which caused frequent criticism: one system produced micro units, and the other the macro units. The previous structure of multiple systems excluded their joint utilization and necessitated tedious conversions in working out problems.

The MKS systems is much simpler. The project specifies that most of its units shall have simple names without any metric prefixes. Thus the basic system can be used in any multiple variations. This can be done by inserting, when substituting numerical values in the formula, powers of ten which serve as metric prefixes.

Sample Problem: To estimate the work of expansion of gas under constant pressure P equals 20 newtons per square centimeter, if the increase in volume ΔV equals 5 cubic decimeters.

According to the general formula $A = p\Delta V$, we have $A = 20 \frac{\text{newtons}}{(0.01\ \text{meter})^2} \times 5(0.1\ \text{meter})^3 = 20 \times 5 \frac{10^{-3}}{10^{-4}}$ newtonometers = 1000 joules = 1 kilojoule.

In both the statement and solution we use units considered outside the system relative to MKS. The only exception in this orderly system is the kilogram itself -- the basic mass unit. It would be advisable to change its name in such a way that the metric prefix would disappear entirely. A long time ago, I recommended as a synonym for kilogram, the old word funt (pound) [5]. But M. F. Malikov was opposed to it, pointing out historical instances where the combining of the two definitions for the old and new units brought only confusion [9]. Consequently, an entirely new word should be found. The well-established name kilo could be changed slightly, perhaps into kil, or kilon. I think, in practice, such a change could take place painlessly, and would greatly simplify calculations. Obviously, 1 gram equals 1 millikilo; 1 ton equals 1 kilokilo.

In view of these considerations, it would also be wise to change kilogram-force to grav, and not kilograv, assuming: 1 grav equals 9.8 newtons; 1 gravometer equals 9.8 joules, etc.

Remarks on the Project

1. It would be useful to adopt individual names for the majority of the derived units of the basic system, as is done for electromagnetic units. For example:

$v = \text{meter}^3$ = "ster" (old metric term)

$S = \text{meter}^2$ = "plan" (analogous to preceding)

$a = \frac{\text{meter}}{\text{second}^2}$ = "gal" (excluding this term from CGS system)

$D = \frac{\text{kil}}{\text{meter}^3}$ = "archimed"

$P = \frac{\text{newton}}{\text{meter}^2}$ = "lomon"

The name of the unit of pressure, "lomon," is recommended in honor of M. V. Lomonosov, who devoted much of his time to studies of atmospheric phenomena on the planet Venus, and who was the first to disclose the concept of the kinetic theory of gases.

2. The GOST should, at the same time, indicate the letter symbols for the given dimensions as well as the equations which determine their values. This is done by L. A. Sena [6] and, in connection with electrical dimensions, by M. F. Malikov [7] and S. F. Malikov [8] The project for corresponding GOST forms was proposed by this writer [5].

3. The Roman titles of the MKS, CGS, and MkGS unit systems should continue to be used, paralleling the Russian MKS, TsZhS, and MkGS.

4. The unit of ton-force was absent in former standards and there is little need to include it in the new GOST.

5. The previous standards preferred the use of kilowatt over horsepower. In the new project, these limitations no longer exist. The temporary character of this unit should be stressed even more in the next GOST, or it should be excluded altogether.

Conclusions

1. The next GOST should standardize as a basic system only one system of units, the MKS, with its subsequent extension to thermal and electromagnetic phenomena.

2 The CGS and technical MkGS systems should be standardized as auxiliary ones (the technical system merely for a short term of 3 to 5 years).

3. It is advisable to change the name of the basic unit of mass, the kilogram, in such a way that the new name will not contain metric prefixes.

4. The unit of force in the technical system should be changed to kilograv, or, even better, to grav. The term kilogram-force should be excluded altogether.

5. Individual names should be given to the majority of the derived units of the basic MKS system.

6. The term inerta should be considered as well-chosen for the technical system.

7. Columns should be added to the GOST indicating the symbols for the dimensions, and the equations defining them.

BIBLIOGRAPHY

1. K. M. Polivanov, "Collection of Works by the Committee for Units of Measurement," Dept Tech Sci, Acad Sci USSR, p 39, 1938

2. O. D. Khvol'son, "Physics Course," Vol I, 1933

3. OST VKS 6259 - Thermal Units and OST 515 - International Electrical Units

4. V. Ye Solov'yev, "Classification of Unit Systems," Scientific Records of the Dnepropetrovsk State, Vol XXXIV, 1948

5. V. Ye. Solov'yev, "Elektrichestvo," No 1, 1949, p 59

6. L. A. Sena, "Units for Measuring Physical Values," 1948

7. M. F. Malikov, "Definition of Electrical and Magnetic Units in the MKS μ_0 Absolute Electromagnetic System," L. 1939

8. S. F. Malikov, "Practical Electrical Units," M. L. 1947

9. M. F. Malikov, "Elektrichestvo," No 1, 1949, p 71

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