Preferred numbers

Preferred numbers and series of preferred numbers

Investigated questions:

1 Prefered numbers definition

2 Preferred numbers on the base of geometrical progression

3 Preferred numbers on the base of arifmetical progression

System of preferred numbers

- Preferred numbers and series of preferred numbers are the basis for choosing the values and gradations of the parameters of all kinds of products

- The use of preferred numbers reduces the number of product sizes, economically uses raw materials, reconciles the parameters of the product, semi-finished products, materials, vehicles, technological, control and other equipment (capacity, dimensions, etc.)

Preferred numbers

In machine building and instrument making, the preferred numbers adopted as the basis for the designation of precision, linear dimensions, angles, radii, ledges, reduce the range of cutting and measuring tools, dies, molds, devices. This contributes to the growth of the level of interchangeability, increased seriality, technical level and quality of products, expansion of its production volumes, improvement of the organization of instrumental facilities in the enterprise.

Preferred numbers

- The use of preferred numbers in the design allows for the interchangeability of parts and assembly units, the unification of machine designs.

- Systems of preferred numbers are established by the interstate standard ГОСТ 8032-84

- Types of preferred numbers:
  - on the base of geometrical progression;
  - on the base of arifmetical progression;
  - special series of preferred numbers.

Preferred numbers based on geometric progression

The standard sets are the following series of numbers:

- 4 basic (R5, R10, R20, R40);
- 2 additional (R80, R160).

These numbers include preferred numbers, representing rounded values of irrational numbers that make up the geometric progression with the denominator , (1)

$$\sqrt[R]{10}$$

where R is an exponent equal to 5; 10; 20; 40; 80 и 160.

Basic parameters of preferred numbers series based on geometric progression

- Denominators of series of geometric progression is rounded off numbers. For instance, exact denominator value of R5 series is equal to 1,5849, rounded off - ≈ 1,6.
- Relative difference between calculated and rounded off numbers of series denominator values based on geometrical progression is within 1,26 to -1,01 %.
- Power of root «R» is included in conditional denotation of series: the fifth series - R5, the tenth series - R10 etc.

Preferred numbers based on geometric progression

- The expression of the i-th term of a geometric progression in general form is determined from the expression:

$$g_i = \pm 10^{\,i/R}, \qquad (2)$$

where i is an integer in the range from 0 to R.

- Deviations from preferred numbers and their series are allowed if:

  - rounding to the preferred number is beyond the permissible error (from plus 1.26 to minus 1.01%);
  - the values of the parameters of technical objects follow regularities that differ from the geometric progression.

Main row parameters of preferred numbers based on geometric progression

Row	Symbol	Progression denominator	Number of members in the decimal interval
Main	R5	≈ 1,6	5
	R10	≈ 1,25	10
	R20	≈ 1,12	20
	R40	≈ 1,06	40
Additional	R80	≈ 1,03	80
	R160	≈ 1,015	160

Preferred numbers based on geometric progression

- In the general case, a number of with a smaller serial number. For example, row R5 is preferable to the R10 series, etc.
- In the row R10 includes all numbers of the row R5, in the row R20 – all number of rows R5 and R10, in the row R40- all numbers of the rows R5, R10 and R20.

Main parameters of series of preferred numbers based on a geometric progression

- Members of series of preferred numbers are rounded number obtained after multiplying the previous number by the denominator of the progression.For example, the number of R5 in the size range from 1 to 10 mm has the following preferred number: 1,0; 1,6; 2,5; 4,0; 6,3; 10,0 mm, and in some R10: 1,00; 1,25; 1,60; 2,00; 2,50; 3,15; 4,00; 5,00; 6,30; 8,00; 10,00 mm.
- The series of preferred numbers is infinite. More than 10 in each decimal interval (from 10 to 100, from 100 to 1000 and above) is obtained by multiplying the preferred numbers contained in the interval from 1 to 10, 10, and 100, etc.

Properties of preferred numbers on the base of geometrical progression

- Quantity of members in each decimal progression data interval (1 – 10; 10 – 100; 100 -1000 etc., and also 1 – 0,1; 0,1 – 0,01; 0,01 – 0,001 etc..) constantly all progression through and equals 5, 10, 20, 40, 80 and 160.
- In rows, except the row R5, there is a number 3,15, which is approximately equal to  . Therefore the length of a circumference and circle area, diameter of which is preferred number, are also preferred numbers.
- Row R40 contains number 375, 750, 1500 and 3000, which have special meaning в electrical engineering, so as they _ express rotations per minute numbers of asynchronous engines.

Properties of preferred numbers based on geometrical progresion

- **The product or the quotient of 2 preferred** numbers, and positive or negative stages of row numbers give preferred number of this row with relative error within the limits from minus 1.01 to plus 1.26%
- Cube of any number of the R10 row will be twice bigger of previous cube number, but the square will be in 1.6 times more of previous square number with mentioned error
- Members of a row R10 doubles every 3 numbers in a row
- In each interval percent of increasing the value of number is unchanged, the disadvantage is mandatory rounding of all its members.

Derived series of preferred numbers

- Based on the simplest transformations of a geometric progression, three derived series can be obtained:
  -decreasing series of preferred numbers:

$$\downarrow g_i = 10^{-i/R} \qquad (3)$$

  - complementary preferred numbers:

$$\overline{g}_i = 10^m - 10^{-i/R} \qquad (4)$$

  - arithmetic preferred series of numbers:

$$a_i = a_0 \pm (10^m \cdot i/R), \qquad (5)$$

  on condition, that a_0 is the multiple $10^{m/R}$ and

$$| a_i (10^{m/R}) | \leq 100.$$

Field of usage of complementary preferred numbers

Complementary preferred numbers should be used to establish parameters approaching 10m, for example, efficiency, probability of failure-free operation, confidence probability of an event.

The designation of the complementary series is obtained by adding to the notation of the original main (additional) series the sign "¯", for example: R̄5.