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THE MODERN TRENDS OF DEVELOPMENT OF THE PIPE AND TUBE INDUSTRY

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First the paper presents a review of steel production of the tubes in world: possible potencial is about 110 × 10^6 the tons (35 × 10^6 seamless tubes, rest welding tubes). In 2007. y. was record volume of 88,6 ×10^6 tons in world; 6,5 % of total production of steel in world. Ratio-weldeds tubes: seamless tubes 70:30 %. Further in the article are presented urgent the problems of the pipe and tube industry.

Key words: seamless tubes, weldeds tubes, production, problems, development

Suvremeni putokazi razvitka industrije cijevi. Prvi dio članka daje pregled proizvodnje čeličnih cijevi u svijetu: moguća je proizvodnost 110 × 10^6 tona (35 × 10^6 tona bešavnih cijevi, ostatak šavne cijevi). U 2007. god. bila je rekordna proizvodnja cijevi u svijetu 88,6 × 10^6 tona, tj. 6,5 % od ukupne proizvodnje čelika u svijetu. Odnos – šavne cijevi: bešavne cijevi 70:30 %. U nastavku članka su navedeni žurni problemi u industriji cijevi.

Ključne riječi: bešavne cijevi, šavne cijevi, proizvodnja, problemi, razvitak

INTRODUCTION

Great efforts have been recently made in the world of metallurgy in order to reduce raw material consumption and particularly energy consumption. Although most metallurgical products are produced by the proved procedures of plastic forming, some changes appear owing to the following requirements:

- improvement of product quality,
- reduction of production costs,
- increase of productivity as well as capacity, yield and equipment availability,
- higher flexibility concerning the production program.

The requirements for the quality parameters of hot and cold formed steel and non-ferrous metals increasingly insist upon [1]:

- optimisation of chemical composition,
- improvement of purity grade concerning the non-metal inclusions, oligo-elements and gas contents,
- restricted mechanical properties,
- more suitable and more uniform structure, less segregations,
- closer dimensional tolerances for: section, width, length, (wall thickness for pipes),
- improved straightness for flat products,
- section shape according to the forming procedure,
- improved surface quality (additional by grinding and polishing),
- surface treatment (coating by metals, plastics, varnish, etc.).

Intensive researches in the plastic forming theory and particularly in the process technology development are carried out in order to achieve these high requirements [2, 3].

Nowadays, basic characteristics of world steel production and plastic forming are specified through automation and processes management by means of computers. Actually, computer engineering and technology is a big and significant innovation in the recent years of metallurgy, the innovation being introduced with a great speed. In these days there are no single segment in up-to-date iron works without computers used for informing or processing managements. Production units or production lines without computers are considered to be out-of-date, because of small productivity, inefficiency and high costs. In developed countries, the computers participate with about 90 % in the managing of metallurgical processes in steel producing and plastic deformation.

Therefore, the purpose of this article is to present a review of steel tubes production, especially urgent problems of the pipe and tube industry.

REVIEW OF STEEL TUBES PRODUCTION

In 1970 steel tubes production amounted 7,7 % of world steel production. In 1980 world steel production

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Table 1 **Pipe and tube production volumes in 1999-2008, 10^6 / tons – world total**

Year									
1999	2000	2001	20002	2003	2004	2005	2006	2007	2008
54,563	57,426	57,617	57,688	63,338	70,235	78,805	88,125	88,608	85,216

was 717×10^6 tons, and tubes production was $70,3\times10^6$ tons, i.e. 9,8 %, and as early as in 1981 it increased to 10,8 % (steel - 707×10^6, and tubes $74,8\times10^6$ tons). [4]

It means that the annual rate of increase of tubes production in those years was about 4 % unlike to previous predictions of 1,7 % for the same period.

The long-term prognoses from that time indicated to a possibility of a further increase of steel tubes production so as the annual increase rate be about 1 %. At a lower predicted increase of steel production the portion of tubes in the steel production would grow as far as 11 % (in 2000 an tube production over 80×10^6 tons per year is foreseen).

These assumptions were not realised. Developed industrial countries, after the first and the second world oil crisis, underwent significant changes and restructuring in metallurgy. The fall of production in some countries was as much as 30 %. [5]

The drop of tubes production was especially pronounced (in 1990 - $69,4\times10^6$ tons; in 1994 - 53×10^6 tons). This concerned the 6 most developed countries including the Commonwealth of Independent States (former USSR), which had nearly 90% of total world tube production. All kinds of tubes experienced then a drop of production level. Production drop of small diameter welded tubes reached 9 %. Large diameter welded tubes had a production drop for 14 %. The production of welded tubes dropped in total over 10 %. [6, 7]

Seamless tubes experienced a significant decrease of production (over 17 %). Then, the production amounted about 17×10^6 tons (1998 – $15,1\times10^6$ tons).

The present-day steel pipe and tube production facilities are situated round the world in 60 countries (32 countries have seamless tube production facilities) and possessed by more than 500 pipe and tube producing companies having around 1000 production floors. Possible potential of annual production of steel pipes and tubes is about 110 million tons (about 35 million tons of seamless tubes). In 2007, total world production of steel pipes and tubes has reached a record volume of 89 million tons (27 million tons and 62 million tons of seamless and welded pipes and tubes respectively i.e. ratio 30:70 %). At the same time, seamless tubes come to more than 35 % of the gross national product of industrially developed countries.

In EU structure of steel tube industry – 2002 y: Total ratio – weldeds tubes: seamless tubes was 74,7 : 25,3 %; 2008 y: this ratio was 64,3 : 35,7 %. In nafta (USA, Canada, Mexico) – 2008 y., this ratio was 63,8 : 36,2 %

Globally, pipes and tubes find an ever growing use that defines the technological standing of majority of economic complexes of an utmost importance, such as fuel and energy complex, machine-building industry, housing and communal services, agriculture, etc. At that, about 90 % of the manufactured tubular products are used for the production needs (making machines, apparatus and mechanisms, well-boring, building pipelines and various structures) and the rest of the pipes and tubes are used in repair and operation fields. [9]

The years of 1999 to 2007 had witnessed a constant growth of steel pipe and tube production. This trend was characteristic to world total (see Table 1).

Very intresting is ratio production of steel and production of all tubes in world total:

- in 1970 – 7,7 %; in 1981 – 10,8 %;
- in 2007 production of steel – $1.343,5\times10^6$ tons – production of all tubes (record volume) $88,608\times10^6$ tons – 6,5 %.
- In 2008 y, world total ratio production of steel and production of all tubes was approximate egal.
- In first six months 2009 y production of steel (and also of tubes) decrease about 20 % in correlation with 2008 y.

URGENT PROBLEMS OF THE PIPE AND TUBE INDUSTRY

Traditionally, the pipe and tube industry is considered to be a separate branch of ferrous metallurgy producing the most technologically complicated goods. At present, there are numerous illustrations of transition of the pipe and tube branch to a qualitatively new stage of development featuring a tendency to the promotion of "self-dependent specialization" in the development of large pipe and tube enterprises. This trend is assisted by a number of factors of which determining ones are as follows:

a) growth of requirements to pipe and tube quality arising from toughening of their service conditions and requirements of long-term fail-safety that is substantially determined by the quality of the initial material;
b) disparateness of technical and economic interests of steel producers who are interested above all in the growth of metal production and shipped tonnages and the interests of the pipe and tube producers who need starting materials having special quality characteristics and require comparatively limited metal supply lots.

The above factors predetermine the present-day trends of creation of separate specialized process chains

within the pipe and tube producing companies: from metal smelting to finished tube production.

Analysis of world trends of tubular goods consumption in previous 7-10 years has shown that the main field of application of *steel pipes* (more than 50 % of the total production volume) is construction of various pipelines. Welded large diameter pipes, welded and seamless oil line pipes, water and gas line pipes and general purpose seamless tubes are widely used in pipeline construction. Around 20 % of the world steel tube turnover account for threaded oil country tubular goods (OCTG). About 30 % of the produced tubes are used in the machine building industry as half-finished goods that undergo a more or less complex processing in making parts, assemblies and machinery components.

The most urgent problems facing the pipe and tube producers are as follows:

a) improvement of strength and plastic properties of the tube material thru the use of low-alloy and alloy steel grades;
b) improvement of dimensional accuracy and quality of pipes and tubes thru installation of new equipment, introduction of progressive manufacturing processes and automated control systems, perfection of quality control methods;
c) application of progressive types of thermal treatment;
d) mastering the production of new economical product kinds ensuring metal savings thru augmentation of structural strength, service reliability and durability.

Steady rise of hydrocarbon fuel prices and the key role of pipeline transportation systems in the supply of energy resources predetermine the task of providing power engineering industry with high-tech tubular goods. Production of welded large diameter oil and gas line pipes is dynamically advancing along with the pipeline transport development featuring the following trends:

a) boosting pipeline throughput and working pressures up to 25 MPa (gas pipelines) and 14 MPa (oil pipelines);
b) rapid advancement of underwater pipeline construction;
c) expansion of construction of pipelines in seismic, permafrost and marshland areas;
d) toughening requirements to reliability of pipelines as crucial strategic units of national safety;
e) wide spread mechanization of construction works requiring tougher pipe dimensional accuracy and maximum reduction of number of the end joints welded in field conditions.

The present-day trends of development of the pipeline transport and ever toughening requirements to its reliability pose new problems before the pipe and tube producers from the point of view of changes in their product grades and making more precise pipe and tube specifications. The most urgent problems are as follows:

a) organization of production of thick-walled (up to 36-52 mm), pipes to be used in construction of pipelines operated at high working pressures (up to 25 MPa);
b) guarantying pipe metal strength of up to K65 (X80) at present and up to K80-K100 (X100-X120) in the nearest future as it is determined by the growth of steel intensity in the pipe manufacture;
c) upgrading requirements to base and weld metal ductility;
d) toughening (1,5-3 times) requirements to the pipe end and body roundness;
e) organization of production of long (up to 18 m and longer) pipes with no girth joints;
f) expansion of the production of lined pipes for underwater pipelines.

In the field of production small and medium diameter welded pipes, the most urgent problems are as follows:

a) upgrading strength characteristics (up to X80), increasing wall thickness (up to 22 mm) and toughening requirements to quality and impact toughness of weld seams in oil and gas line pipes;
b) expansion of production of corrosion-resistant pipes and pipes suitable foк operation in low-temperature (up to -60 ºC) operating conditions;
c) increasing share of shaped pipes within the production volumes of electric welding mills (up to 50-60 %) including large size (up to 400 × 400 mm) shaped pipes with wall thickness of 14-16 mm;
d) application of new technologies and equipment ensuring higher (up to 10-15 m/min) speeds of argon-arc or laser welding, weld seam plugging, thermal treatment in a protective atmosphere, NDT of stainless steel pipes in the mill line.

At present, pipe and tube producers strive for the provision of their customers with pipes and tubes complete with fittings. In this connection, inclusion of specialized facilities for the production of connection fittings into the existing production facilities is of current importance for large pipe and tube producers.

As before, choice of optimum tool designs and forming regimes is relevant for the pipe and tube producers. Differentiated (depending on steel grades, elongation, billet and tube dimensions) approach to the choice of tool (rolls, dies, etc.) design parameters, temperature and deformation (rolling, drawing, extrusion, etc.) speed can substantially improve product quality and cut energy consumption. Solution of these problems requires, first of all, a further improvement of analysis methods and perfection of experimental investigation of the pipe and tube production processes.

A rather urgent problem of efficient functioning of economy is making longer life and higher reliabiliy of pipes and tubes by application of protective coatings. In the first place, it pertains to municipal economy and heat-and-power engineering where the tube service life gets shorter steadily because of ever growing media (both transported and surrounding) aggressivity resulting in great losses of energy resources and metal products and a considerable growth of pipeline repair, erection and laying costs. To cope with these problems, protective coatings are applied on the inside and outside surface of pipes. Beside 5-7 times longer their service life, pipes with such coatings ensure a radical reduction of heat loss (up to 80-90 %), pollutant emissions (up to 80 %), pipeline laying and maintenance costs (up to 40 %). It is evident that the share of pipes with various protective coatings will steadily grow in the nearest future.

It is obvious that the abovementioned technical aspects of development of the pipe and tube industry cannot be fully realized without taking into account a positive experience gained in institutional base reorganization. Analysis of main trends of development during last 25-30 years of the world largest pipe and tube works having production structure that was formed during many decades and acquired *"natural market stability"* shows a pronounced tendency to expansion of the product and service range within *one* concern (consortium or industrial group). It makes the processes of intensive *marketing* and *diversification* rather urgent.

CONCLUSION

1. Possible potential of annual production of steel pipes and tubes is about 110 million tons (about 35 million tons of seamless tubes).

2. In 2007, total world production of steel pipes and tubes has reached a record volume of 89 million tons (27 million tons and 62 million tons of seamless and welded pipes and tubes respectively).

3. Analysis of world trends of tubular goods consumption in previous 7-10 years has shown that the main field of application of *steel pipes* (more than 50 % of the total production volume) is construction of various pipelines.

4. The above factors predetermine the present-day trends of creation of separate specialized process chains within the pipe and tube producing companies: from metal smelting to finished tube production.

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Note: The responsible translator for English language is National metallurgical Academy, Ukraine.