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INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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50X1-HUM

COUNTRY USSR (Moscow Oblast)

REPORT

SUBJECT 1. Metallurgical Institute i/n A.A.Baykov of USSR Academy of Sciences, Moscow
2. The Central Scientific Research Institute of Ferrous Metallurgy (TsNIIChM)

DATE DISTR. 15 November 1961

NO. PAGES 1

REFERENCES

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DATE OF INFO.

PLACE & DATE ACQ.

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SOURCE EVALUATIONS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

Attachment 1: Metallurgical Institute i/n A.A. Baykov of USSR Academy of Sciences, Moscow. Details on: ancillary installations at Novo Tula; current projects in some 20 laboratories; Metal Reduction Laboratory; names of Soviets supervising laboratories.

Attachment 2: The Central Scientific Research Institute of Ferrous Metallurgy (TsNIIChM). Details on: ultra-sonic treatment of alloys; low-temperature research; automation laboratory; continuous casting; electrometallurgy of steel; converter laboratory; open-hearth laboratory; blast-furnace laboratory.

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The BAIKOV Institute

1. In addition to their laboratory facilities, the BAIKOV Institute have the occasional use of a ten-ton converter at the ~~NOVO-TUL'SKII~~ Tula works and pelletising and fluidised bed installations. The pelletiser installation is of the "chemical catalytic" type, ore moistened with a solution of catalyst (undisclosed) and mixed with a little lime is pelletised on a disc; the pellets are then exposed to the action of furnace gases at about 300°C which produces a calcium carbonate bead in the pellet. The pellets are then reduced in the fluidised bed installation.

2. Laboratory work is being carried out on the fluidisation of pellets in a model a few inches in diameter and a larger hot rig. The bed is of the cone entry type and "fountain" rather than "fluidisation" is the effect produced. This ~~NOVO-TUL'SKII~~ TULA installation is working badly and there are small prospects of quick success. Nevertheless a 5-10 ton (of ore) per day installation is being planned.

3. For larger scale work on non-ferrous materials (included in the BAIKOV terms of reference) the Institute has facilities at a coal-washing plant near MOSCOW.

4. The Institute has twenty laboratories. These are crowded, one result of which is delay in completion of projects.

5. One of the major activities of the Institute is vacuum treatment. This work is now almost finished and many reports and books have appeared. 150,000 roubles is the estimate given by SAVRIN as the cost of a complete large vacuum treatment installation based on steam ejectors; with mechanical pumps the cost would be considerably higher. Small ingots are not very suitable for vacuum treatment. For bottom pouring in an inert atmosphere the whole system is placed in a chamber which can be evacuated. The trumpet, closed near the top by a membrane of low-melting alloy, projects through the lid of the chamber. After evacuation the system is filled with argon

with argon and the steel is poured into the trumpet. The membrane melts and pouring proceeds normally. At the end of the pouring the trumpet may be reclosed and the argon pumped for storage; however argon is usually cheap enough to make this not worthwhile.

6. Laboratory work on deoxidation equilibrium in iron and in nickel solution is being done. The structure of liquid alloys is also being studied. A. A. [redacted] of [redacted] has obtained evidence of $\beta - \gamma$ transformation in the liquid state. Electrical conductivity is measured at the same time as viscosity and breaks in the curves correspond to various compounds.

7. Non-metallic inclusions are being studied. One source of these in bottom pouring is thought to be slag accumulated in the horizontal portions of the refractory system and is flushed out if a sudden increase in metal flow rate takes place. Another source is deoxidation products and here laboratory results were obtained in a comparison of silicon and aluminium. This is being carried out by [redacted]; V, iron with 0.016% oxygen is used. Induction melting is carried out under air. With aluminium the inclusions produced in the initial instance of addition are spherical because temperatures rise locally to the melting point of alumina; those formed later are dendritic. With silicon much larger spherical particles (approximately an order larger than those of Al_2O_3) are formed. The rate of flotation of the particles, however, is higher for Al_2O_3 than SiO_2. This is deduced from the very much shorter time for the oxygen content to reach a minimum with aluminium (about half a minute) compared with that of silicon (about fifteen minutes). With both deoxidisers the oxygen content rose again due to interaction with air. The difference between the two deoxidisers is thought to be due to the fact that the silicon is in the form of liquid droplets which are wetted by iron and are thus subject to surface tension effects; alumina particles are solid and are not wetted. Thus possibilities for improving flotation rates by increasing liquid surface tension are at least possible in principle. The Al_2O_3 particles can also be formed as secondary products when the oxygen-aluminium solubility product falls [redacted]

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temperature decreases . In these experiments aluminium is added at the rate of 3 kg per ton steel and silicon at the rate of 10 kg. Further experiments are planned without air access. After this complex deoxidisers will be studied.

8. With silicon deoxidation a plot is made of $K_{si} = (\%si) \times (\%O)^2$ against time. The actual value reached the equilibrium value in about fifteen minutes. With aluminium a 1000-fold divergence of published equilibrium data made a similiar plot less significant, but nevertheless a constant $(Al)^2 \times (O)^3$ value is reached in about three minutes. There is evidence that reaction of aluminium with air oxygen is a surface effect.

9. VERTMAN measuring viscosity during deoxidation plots of visoosity against time found they are in the form of horizontal straight lines with humped portions, the humped portions corresponding exactly to the time needed to reach the "equilibrium" values mentioned above.

10. Data for manganese has been obtained but not yet worked out.

11. In another laboratory the vapour pressure of ferrous oxide, iron and other materials is being determined by a transportion method. Unexpectedly the vapour pressure of ferrous oxide has been found to be higher than that of iron, the equation for the former being

$$\log F = \frac{2100}{T + 2.54}$$

Refractories were present.

12. In the vacuum field, reduction of slags under vacuum is being observed. Stainless steels are being vacuum melted and then cold rolled to a thickness of 10 microns, and desulphurigation of iron at a pressure of 15-20 mm Hg is being studied. With the latter a typical example is a sulphur drop from 0.028 - 0.008 in twenty minutes because of the very violent mixing of slag and metal that occurs under vacuum.

13. In order to supplement or even replace a 10-ton converter as a research tool, the BAIKOV Institute has assembled a laboratory-size converter (30-50 kg charge weight) whose special feature is that the metal can be induction heated, thus giving temperature conditions closely corresponding to those in practice. The curves shown indicate that results obtained both as regards phosphorus distribution between metal /and slag

and slag and the rates of elimination of various elements do indeed correspond to full scale practice. The converter consists of a crucible with eleven turns of 30 mm diameter tubing round it forming an inductor. These turns have bolts welded to them which fit onto a metal frame. A current (maximum 50 kw) is supplied at 2500 c/s from a motor generator. The generator is noisy and is housed in a cellar. During an experiment the inductor is switched down so as to keep the temperature rise corresponding to that in practice; thus there is little stirring due to induction heating. The tuyere is a water cooled pipe; this is also used to take samples from the impact zone. (For this purpose the gas flow is switched off and the end of the tuyere is immersed). The optimum charge weight is about 30 kg. giving complete similarity with a ten-ton converter. To enable efficient operation with different charge weights there are ten condensers each of 31.2 micro-farads which can be switched on singly or together. It has been found that the lower the frequency the better the results. Power is varied by regulating the exciter current. The converter can be tilted to cast the metal into an ingot mould on a wheeled trolley. With this procedure only two men are needed to operate the plant. A hood connected with a number 4 fan (capacity not known) completely prevents fume in the laboratory and discharges into the air. Tuyere movement up and down is mechanised and there is a small hopper for addition of lime to the oxygen flow. This installation is being operated by N. K. LEVENETS under KARASEV and is in the part of the BAIKOV Institute which is under the personal direction of SAMARIN. This laboratory is called "The physical chemistry of steelmaking laboratory" and has a staff of forty-eight, of which approximately twenty-two are graduates.

14. In this same laboratory the production and properties of aluminium steels to replace silicon steels is to be studied. No laboratory work has so far been done. Up to now aluminium has only been studied as an undesirable impurity in silicon steels. A survey of all available literature on aluminium steels is being carried out.

/15. The Metal Reduction Laboratory

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15. The Metal Reduction Laboratory, in the past known as the "Metallurgy of Pig Iron" laboratory, is directed by Professor [redacted]. Problems studied are:

a) Physical properties of slags at high temperature. This has so far mainly consisted in viscosity studies but a high-temperature calorimeter is now being equipped to determine total heats.

b) Blast furnace slag viscosity problems (but on a small scale). Of three viscometers in the laboratory only one was in working order. These are of the rotating type invented by [redacted] eight to ten years ago and now used in Germany and China.

c) Fluidised-bed reduction.

d) Reduction at high pressures, and the effect of pressure on metalloid reduction.

e) Blast furnace materials (testing in a small blast furnace). At present the main effort is on fuels, though the small size of the laboratory's furnace (7.0 cu. ft.) restricts study to chemical effects.

f) Reducibility of ores and sinters at various temperatures (700-1100°C) in hydrogen, CO, or their mixtures. There is no standard reducibility test in the U.S.S.R. and this work aims at finding conditions most indicative of materials' behaviour in the furnace.

g) Softening temperature determination of ores and sinters at 700-1100°C.

h) Studies of phase changes during smelting. (Reduced burden materials have been examined in transmitted and reflected light after cooling).

i) The study of reactions in solid phases. This work has not yet begun but will be the chief new project.

16. Professor [redacted] acts as a referee for papers for publication in STAL' and other journals. He attributes the low standard of many Russian papers

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Russian papers published to poor refereeing, because of overburdening of referees.

17. The work at BAIKOV on external desulphurisation of pig iron in rotating furnaces with lime has been abandoned because of difficulties in suppressing dust formation in lime handling, and because output of the plant was insufficient.

18. Laboratories supervised by Professor OBOZ

a) Rail testing equipment has been extended; three machines are in operation and a fourth is under construction. Something like ten million cycles are made in the course of a test, the stroke of the "wheel" being about one metre. Fatigue testing on smaller specimens is also being extensively carried out. In SOVIET terminology "Dlitel'naya Prochnost" is the time to fracture in a test.

b) In the creep testing laboratories voltage is stabilised; this has been done for 80% of all current in the BAIKOV Institute and has paid for itself on savings in electric bulbs alone. Japanese equipment was in evidence, e.g. a "Union" microscope for use up to 1300°C.

c) In the "electrophysics" department drawing of wire in glass proceeds, Covar alloy being one of the latest to be tried. A 20-meV betatron is being supplemented by a 3-meV lineer accelerator which will be used for studying the effect of particles on metal properties. A new SOVIET-built infra-red microscope, the MIK-1, is in operation. Deposition of thin films of semi-conductors by electron heating is being carried out in a large installation, mainly to produce equipment for use in the Institute itself. For safety this installation, and several others where radiation dangers could arise, are equipped with closed circuit television for remote observation.

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19. Research Programme

At BAIKOV this is decided as follows: The Director of the

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Institute (as of other research institutes) is a member of the Academy of Sciences Department of Technical Sciences. This Director has a scientific council, over half the members of which are outside the Institute, and include production personnel. The Scientific Council is advised by two committees, one on metallurgy (broadly speaking, production metallurgy) and one on the physics of metals (that is, on the field supervised by Professor CHANG). These committees consist of institute personnel only, chosen for their academic qualifications and experience. It is in these committees that projects are critically examined. The recommendations of the committee are considered by the Council, which then makes its own recommendations to the Director, and through him to the Academy of Sciences. Funds are made available from the Academy of Sciences. The services of the Institute are not available on a contract basis, so that the decentralized Soviet steel industry must rely for the type of work done at the Institute on its own research facilities or on being able to influence the Institute programme through the Council.

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The Central Scientific Institute of Ferrous Metallurgy (TSNIICHERMET) Rossavel

TsNIIChM (Moscow)

1. Ultra-sonic Treatment of Alloys

An installation for ultra-sonic treatment of alloys during crystallization, in existence since 1958, is still being used but for an increasing range of metals and alloys. Results indicate increases in plasticity of several fold and considerable grain refinement. [redacted] 50X1-HUM [redacted] the installation will soon be used to produce batches of material for sale. Power available for vibration is 200 kw, but generally much less is used. The frequency is about 0.7 of a kilocycle. For heating a 100 kw inductor (machine generator) is available with frequencies of 2500 cycles per second and over. 50X1-HUM

2. Low Temperature Research

An installation for producing liquid hydrogen and liquid helium for low-temperature research is housed in one of the attics of the Institute. The compressors have a special vibration-suppressing mounting designed at the Institute. This installation produces 6 litres of helium or 8 litres of hydrogen per hour. The attic is used for explosion safety reasons. The Institute is unaware of the GRAVINER explosion suppression system and descriptive literature is wanted by V. V. MARKELOV, who is a mechanical engineer responsible for the design of most of the equipment at the Institute. He is also an excellent technical interpreter.

3. Automation Laboratory

The Head of the Laboratory is KUNITSKII. He is working on automation of rolling mills. The work is based on producing three transistorised units for solution of equations. Blast furnace automation is also being studied but personnel have insufficient knowledge of basic correlations. However, the main effort of the Institute in this field is the study of blast furnace process, and some successes are claimed on partial automation based on temperature measurement around the furnace throat. 50X1-HUM

In another laboratory [redacted]

4. In another laboratory fume prevention is under study. The idea of injecting converter dirty gas into the blast furnaces is not being considered. Strict clean air requirements are causing anxiety in Soviet industry.

5. Continuous Casting

Research work on continuous casting is taking place on improving mould design, the casting of slabs in an increasing range of compositions (there are a large number of macrosections in the laboratory) and horizontal casting. Problems on horizontal casting are still far from solution. The integration of continuous casting in flowsheets and its automation is occupying an increasing proportion of attention now that the technical problems of vertical machines are claimed to have been solved. The laboratory considers that really thin slabs can not be cast and that it would, therefore, not be practicable to link continuous casting directly with a planetary mill. The difference in linear speeds of metal in the two processes is another unfavourable factor. The TSNIICHERMET view on integration with converters is that for two working converters (i.e. a three-converter shop) three machines are needed.

6. Electrometallurgy of Steel

The 'Electrometallurgy of Steel' laboratory has a staff of about twenty, approximately fifteen being graduates. The staff is mainly occupied at works, a recent project being the use of synthetic slags (mainly liquid) for arc furnace metal refinery. Laboratory projects are:

(a) External desulphurization

(b) Mechanism of decarburization

(c) Dephosphorization reactions

(d) Slag/metal reaction kinetics

7. Converter Laboratory

This laboratory has a staff of twelve, three with degrees. It does no strict laboratory work at all, relying on the Thermotechnical Laboratory of the Institute for model work and supplying it in turn with any necessary process information. Again on a 10-ton converter at the NOVO-~~TUL'SKII~~ TULA works this laboratory staff has developed a process (on the basis of BAIKOV Institute results on a 30 kg converter) for treating vanadium-rich iron obtained from Kachkanar ores. A V-rich slag is first

 produced by [redacted]

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produced by keeping the temperature low, and is run off. The main remaining impurity is carbon, which is removed in the second stage. Because of difficulties in slag removal on the 10-ton converter the procedure actually adopted is to tap the metal, then the slag and then replace the metal.

8. Open Hearth Laboratory

This laboratory has a staff of eighteeen, twelve with degrees. Though laboratory facilities are available they have no time to use them, being fully occupied with works trials. The small Open Hearth at the NOVO-~~TUL'SKII~~ TULA combine is not available for their researches. Although all refractories research is now done at specialized institutes results of works trials are communicated to TSNIICHERMET for considera'ion.

9. Blast Furnace Laboratory

The blast furnace laboratory strength is not known but the laboratory is almost entirely occupied with works trials and data analysis. A large double Tamman furance is installed but this has been out of use for some time. Until 1960 the NOVO-TUL'SKII works' blast furnace (335 m^3) was available for experiments, but this has now been replaced by a much larger unit.