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14784

10 Nov.1983
English

Yugoslavia.

TECHNICAL ASSISTANCE TO THE INDUSTRY OF ENGINE PARTS AND ALLIED COMPONENTS.

Technical report.

SI/YUG/82/803

Prepared for the Goverment of Yugoslavia by
United Nations Industrial Development
Organization executing agency for the
United Nations Development Programe

Based on the work of J.M.Krasnicki specialist
in foundry equipment

United Nations Industrial Development Organization

Vienna

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Abstract

Project Nr : SI/YUG/82/003/11-02/31.9.A
Project title: TECHNICAL ASSISTANCE TO THE INDUSTRY OF ENGINE PARTS AND ALLIED COMPONENTS, YUGOSLAVIA
Post title : SPECIALIST IN THE CONSTRUCTION OF FOUNDRY EQUIPMENT FOR CENTRIFUGAL CASTING

During the short - term assignment lasting 1,6 months the work was concentrated on problems of production of cylinder liners in the foundry "27 Mart" in Novi Sad, Yugoslavia, specifically design of equipment.
Improvements into the operation of feeding of the centrifugal machines, into construction of these machines and organization of work havebeen proposed, aiming to increase the accuracy of raw liners, reduction of personnel and increase the output.
Detailed list of technical equipment recommended to purchase is annexed and the draft program of further actions which should be undertaken to improve the centrifugal casting process in the "27 Mart" factory.

I. GENERAL DATA ABOUT THE FACTORY "NO 27 MAY"
NOVI SAD, YUGOSLAVIA

The factory situated at the outskirts of Novi Sad, the capital of autonomous region Vojvodina employs about 1900 people and the production programme covers parts and subassemblies of engines and automobiles: cylinder liners /centrifugal casting/, pistons, piston rings, piston sets, ribbed cylinders /Cromin, process/, motor heads valve seats and guides veribus machine parts and tools. The main plants of the factory are; the foundry and the machine plant.
The factory has 55 years old history, but the present objects were erected about 20 years ago, basing on the Soviet documentation and supplies.
In spite of experienced and devoted manpower relatively good technological discipline the technical and economic results, specially of the foundry, are poor.
This situation should be attributed to old, greatly depreciated machines, generally out - of date technology, lack of modern auxiliary and control equipment, poor quality of auxiliary materials. Purchase of induction chennel type furnaces is the sign of some improvement in this field.
The main product of the factory are cylinder liners /the present production range about 450.000 pcs finished liners p.a./ with real chances to increase the output up to 1 milion pcs p.a. due to favourable situation in the market.
Therefore strong emphasis should be put in this project on problems concerning liners /design of machines and moulds, metallurgy, organization of work/ to gain maximum increase of output with minimum investment costs and without standstills in production.

II. EXISTING SERIES OF PRODUCTION [illegible]

In the present production programme of cylinder liners prevail Diesel engines liners /MAN, Perkins/, the next group form "[illegible]" and "mod" Otto engines liners, the least numerous group comprises liners.

The longest series: MAN /340.000 pcs/year/, Perkins /50.000 pcs/year/. The dimensions of a representative MAN liner: Do : [illegible] mm, Di = 110 mm; weight: 14 kGs. The dimensions of a Perkins liner Do = 89 mm, D_1= 103 mm; weight: 5,5 kGs.

The liners are manufactured of low-alloy grey iron with increased contents of Cr. Approximative pouring temperature: 1350 °C.

The acceptance procedure in the foundry comprises; hardness measurements /220 - 250 H_B/ and metallographic structure test /perlito/.

Iron for liners is melted in two 8 tons cupola furnaces with tilting receivers. It is poured from a receiver to the ladle 500 kGs hanging on a monorail and is transported to the centrifugal machines.

These machines are grouped in two stands :

- the big 12 - position carousel Soviet manufacture
- stand of fourteen small cetrifugal machines CFM-3 Polish manufacture. All these machines

have horizontal axis of rotation and are water - cooled.

The carousel in poured directly from the ladle 500 kGs / with by - weight batching device/, metal for small machines is first desulphurized /by means of soda ash/, then poured to a small tilting tank, from which it is batched by weight to small manual ladles /shanks/.

The "dry" mould surface coat for iron of the commercial name "Domžali" /Yugoslavian product/ is used here.

Liners - solidified and cooled to the temperature about 700°C - are pulled out from the machine and put on the chute from which they fall onto the underground apron conveyer. At the outlet of the conveyer the first technical inspection takes place and then castings are thermally treated /stress - relieving, 2 hours 450 - 550°C /.

The productivity of the carousel : 1200 pcs / shift with the manpower 7 persons.

The productivity of small centrifugal machines :
1200 pcs / shift, with manpower 12 persons.
Metal consumption: the carousel 16 tons / shift,
the small centrifugal machines: 8,5 tons / shift.
Due to excessive machining allowances and high percent of scrap the general yield of production of liners is very low /e.g. 40% for MAN liners /.

Analysis of the stand of small centrifugal machines

In accordance with suggestions of the management of the foundry the operations of machines CFM-3 was analized more careful
The average cycle of work of a machine lasts about 120 sec and consists of the following operations:

- rotation, including pouring, solidification and cooling	150 sec	/1/
- removing of front bottom and of the liner	30 "	/2/
cleening of the mould /with brush and compressed air/	30 "	/3/
- introducing of powdered coat	10 "	/4/

The operations /1/ and /2/ last too long. The theoretical time from pouring to renoval of a casting - when cooling with water - amounts. 76 sec. The operation of removing of a hot liner is done manually using method of rapping, is not only time - consuming but also very tiring.
The personnel of the stand is too numerous /totally 12 persons/ : 1 worker is busy with transport of metal from the cupola, 1 person the tilting tank and the weigh, 2 pour machines, 7 operate machines, 1 is responsible for coats.
The average scrap /outfoll/ amounts ob. 30% .
Causes of outfoll can be divided into four groups :

-inclusions of sand on outer surface of the liner	- 15%
- slag inclusions near inner surface	- 10%
- wrong structure /presence of cementite /	- 3%
- not met dimensional tolerances	

The extremely small area between two rows of machines and worn, slippery floor create a real hazard for workers who handle there with molten metal and hot castings.
In conclusion, the stand of small centrifugal machines CFM-3 requires immediate innovations and reconstruction.

MEASURERS AND ACTIONS PROPOSED TO IMPROVE THE QUALITY OF PRODUCT AND INCREASE THE OUTPUT OF SMALL CENTRIFUGAL MACHINES
(presented in drwgs.1,2,3)

The main problem,how to increase the dimensional accuracy of cilinder liners and to reduce the number of workers employed on this stand,can be best disolved by introducing the "by weigh" dosing of iron into the machines.The only new equipment in the system will be the mechanical,dial weigh hanging under a monorail track and carring hoist with the ladle 200 KGs capacity.The detailed technical specifications for the weigh are listed in the Annex 1.

The batches of liquid iron previously determinated and set on the weigh will be signalled by means of electric signals,i.e. the color bulbs on the perimeter of the weigh and on the ladle holder, near the operator's eyes,will flash.The button to readjust "0" after each filling of the ladle should be located on ladle holder in the reach of operator's hand.The capacity of the ladle (200 KGs) is sufficient(with reserve)to pour all the machines CFM-3 working in the stand(13 pcs according to the drwg.1).

The transport system of two tracks:track "A" (existing)with a ladle 500 KGs from the cupolas to the place where filling of the ladles 200 KGs and modification of metal will take place and track "B" -in the shape of a closed loop,where two ladles 200 KGs will circulate working in continuous (cyclic) system of work.

Short distances,litle space,many starts and stoppages make it imprectical and not economical to introduce electric drive for ladles.

Therefore the conception (drwg.1) is based on "CENTROZAP" manually operated equipment,listed in the Annex 2.It is strongly recommended or to

purchase this equipment or to design the new one basing on the "CENTROZAP" elements as a model.

To obtain more space for operation of ladles the left row of machine (together with chutes) should be displaced at the distance about 1300 mm to the left (facing to the carousel).To improve the safety conditions the whole floor inside the stand should be replaced.

Drwg.2 presents interim solution (e.g. during a failure of the weigh) ... that is "by volume" system of batching.The pouring box having volume exactly equal to the volume of metal required to pour the machine,fixed to the inlet trough,has calibrated hole made in core-sleeve,securing outflow of metal at the average speed of 1KG/sek In this variant much depends upon skills of the operator although the dimensional accuracy of the castings will be worse.

After implementation of the changes proposed on the drwg.3 (introducing bronze sleeves,change of material of the pushing piston onto very heat-resistant alloy Prokron 10) the operation of the pushing--out mechanism will run smoothly,without obstaclas and manual dragging of castings.

After implementation of all the proposed changes the fillowing advantages will be obtained:

- good accuracy of the castings (the inside diameter tolerance in the range $\pm$0,4 mm)
- reduced number of personnal (down to 7 persons)
- increased output due to the enforced cyclic system of work.

TECHNICAL SPECIFICATIONS FOR THE MECHANICAL WEIGH

1. High resistance against elevated temperatures, dust, corrosive gases, and mechanical shock.
2. The range of weighing: 0-200 KG.
3. The smalest graduation: 250 G.
4. Automatic redjustment of "0" after a signal of the operator (e.g. after pressing a button by him)
5. The dial should be equipped with a set of adjustable contacts for signalisation purposes.
6. Signalisation-by electric system (own source of energy). Signals, after closing the electric circuit, should be transmitted to the ladle (protective shield on the operator's side) and outside the dial.

Note:

As the alternative to the electric' system of signalization consider the pneumonic system as very reliable in hard conditions of work, in dusty atmosphere, high temperatures and the like. All component elements, including color signalizators are manufactured by many firms, i.a MECMAN, Sweden.

Thin flexibile plastic tubes connecting the weigh with the signalization points are easily repairable in case of breaking or other failure.

Annex 2

TO/

TECHNICAL EQUIPMENT RECOMMENDED FOR PURCHASE IMPROVE THE QALITY OF CENTRIFUGAL CASTINGS

in brackets : the most suitable manufacturers

1. Mechanical dial weigh - redesigned and adapted /LIBELA, Celje, Yugoslavia/ — 2 pcs
2. Monorail track type KMJ-500 — 2 pcs
3. Hand operated hoist type PDR 250 — 2 pcs
4. Ladle holder type UKO-200 — 2 pcs
5. Ladle type KPO 200-200 KGs capacity /for items 2-5: CENTROZAP. Poland /
6. Spectrometer type JY 32E, scope of analisis : about 15 elements /JOBIN YVON, France / — 1 pc
7. Pyrometar type "Pyropto" — 2 pcs

Annex

PROGRAM OF FURTHER ACTIONS WHICH SHOULD BE UNDERTAKEN TO IMPROVE THE CENTRIFUGAL CASTING PROCESS IN THE FOUNDRY

Note:

Program indicates only actions which do not require substantial expenses and which can be realized self - reliantly by the technical personnel of the factory - eventually with assistence of the Novi Sad University or UNIDO experts. The actions are listed according to diminishing importence for the factory.

1. Complex of actions and measures aiming to elimination of surface and subsurface defects on castings /with eventual change of mould surface coat, modificator, introducing of obligatory temperature measurements /.
2. Application of partitioned moulds for manufacture of profiled liners, peculiarly on machines CFM-3. Aim: to reduce machining allowances down to about 2 mm.
3. Reconstruction /redesign/ of the pulling mechanism in the carousel centrifugal machine.
   Aim: to eliminate the very tiring manual operation of "pushing" hot liners from the mechanism and to improve conditions of work.
4. Application of centrifugal casting process to manufacture of piston rings /centrifugal sleeves instead of individual sand casting/.
   Aim: general improvement of economy of production of rings.