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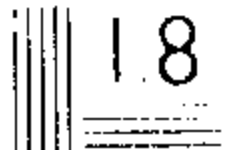
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FINAL REPORT ABOUT PROFESSIONAL ACTIVITIES DURING THE MISSION REALIZATION

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CONTENTS

I N T R O D U C T I O N

In accordance with plans listed in the "Job Description", and objetively possibilities in Querétaro, with reference to CIATEQ (Centro de Investigación y Asistencia Técnica del Estado de Querétaro), by expert has been offered orientation work plan as to professional activities during the mission performing.

Namely, owing to the fact, that CIATEQ as a new institution did not have any programme realization about heat treatment problems in industry, it was inevitable need to visit a few factories. After that have been expected opportunity to find out eventually possibilities for CIATEQ participation in solving some technological problems.

For this purpose has been necessarly to offer team work methodology as to cooperation between CIATEQ and individually factories. Besides that, have been expected some recomendations about research activities or interest for the future.

Having in mind the previously mentioned, after a few factory visits realization, as an interesting technological problem has been chosen the problem of banded structures on some types of forgings produced from case hardening steels. The problem was identified in factory "Engranes Cónicos", which is dealing with machining and heat treatment products finalization, for automotive industry needs.

In accordance with problem's nature, has been appreciated that is a típical problem where can be team work applicated in order to find out adequate solution with regard to the importance of problem, the all efforts have been directed to the activities as are work programme preparation, samples selection, and adequate priscription preparation in order to be ready for program realization.

Besides of the previously mentioned have been elaborated some aspects as to cooperation possibilities between research institution and individualy factories. Especially have been pointed out some ideas as to

possibilities of work research intensifying in CIATEQ.

About jobs which are very important for industry, have been sugeited projects realization for case hardening steels hardenability research and as weel boron micro-alloying steels research as to possibilities in automotive industry application.

Simultaneously, has been recomended the bibliography for heat treatment fields actual in industry.

1. PRESENT CIATEQ'S RESEARCH POSSIBILITIES DESCRIPTION

In order to give a short description of institution CIATEQ, it is neccssarily to point out that is Querétaro City a centro of metal working industry, which is relative young and with present technological problems and as well with pronounced wishes for faster development in the future.

Just because of that, have been increased demands for work research application in industy, in order to make possible of nominated aims realization.

In accordance with industy needs, approximatively one year ago, was set up the institution named "Centro de Investigación y Asistencia Técnica del Estado de Querétaro, A.C." (CIATEQ). At the moment of Institution setting up, have been dominating the motives as fallows:

- Setting up a centre for local industry needs, which has to be the Centre of multidisciplinary activities as to research and consultations;

- For known technology solutions adaptation making, and as well new technology development;

- To be promoter and bearer of new technics and new technology solutions;

- Services making to the industry, by means of a good library and information sistem based on information bank data, from the U S A and Europe.

Havind in mind the former motives, in the frame of CIATEQ's technical function, was pl.ned the fields of professional activities as fallows:

a) Materials production and as well materials processing,
b) Machining and mechanical design;

c) Industrial engineering;
d) Control in industry by electronic application;

At the very beginning of institution werk has been characteristic a lack of experienced staff and necessarily research equipment.

In such circumstances the main working effotts have amitiously been directed to the speculative research activities in order to realize some useful solutions for industry needs.

Namely, have been performed mechanical and production procedure for one type of rotary table with 250 Tons. capacity, for petrol orilling equipment. Within that solution has been done as fallows:

-Has been performed swivel device redesign, where with has been permited rotation and possibilities to be lowered or raised while the drilling mud is being injected into string at 5,000 pounds per square inch.;

-Has been constructed, with 250 tons. capacity the hook with chock absorber, where with has been prolonged the drilling equipment service life;

-In order to subsitute imprortation, with own original solutions, has been constructed an interstage cooler for large air compressors;

Besides of the former, at the moment are actual the activities as fallows:

- On some type of forgings for automotive industry needs, solving the problems conected with banded structures phenomenon

- Selection and modification some steel grades, in order to decrease its costs, and as well achieve a quality improvement;

- Periodicaly services making as to heat treatment practice, standars application and materials selection;

For the future period there is left a need for methodology development as to cooperation practice with industry, step by step research staff completion and long-termed research programme determination.

2. WORK PLAN PROPOSAL AND ITS REALIZATION

According to the JOB DESCRIBTION, the expert is obliged to participate in cooperation with Centro de Investigación y Asistencia Técnica del Estado de Querétaro, (CIATEQ), in realization of jobs mentioned under Items Nos. 1 to 5 incl.

For a successful participation in the mentioned jobs, it is necessary to provide the knowledge of the following facts:

- To get knows with the precious program, now actual, as well as with the anticipation program, relating to CIATEQ.

- To get known with the available aggregates/plants for the steel production, for the steel hot treatment and for the heat treatment of products, having in mind forgings.

- To be introduced with sorts of technological procedures, now actual having in mind the hert treatment of products.

- To get known with actual problems from the domain of the heat treatment of forgings.

- To get known with the available possibilities of CIATEQ, as to the equipment, the personnel staff and the cooperation way with the industry which is to be offered the expert assistance.

After the above and previous introduction into the present and actual conditions, it is possible, through the mutual cooperation, to execute and perform the following jobs:

1. In order to inform and, in the same time, to enhace the staff personnel for a higher motivation within the heat treatment jobs, it is possible to organize a seminar with one of the following themes:

   a) Theoretical Fundamentals of Heat Treatment

b) Essential procedures in Heat Treatment
c) Technology of Heating, Temperature Holding on a Level, Austenitization Process and Cooling
d) Examination of the hardenability of steel
e) Means, Devices and Equipment/ Plants for Heat Treatment
f) Control of Procedures and Means/Devices at Heat Treatment.
g) Practical Instructions for Heat Treatment, having in mind the control process, procedures and the branch/field of the application.

2. Participation in solving the problems relating to the heat treatment for the product of following uses:

   a) Forgings for the uses of the railways/ Railway carriage and wagon axles and tyres/
   b) Forging, for the uses of the power/energy plants, from carbon and alloyed steels.
   c) Forgings for the ship construction
   d) Forgings of special aims from Cr - Mo or Cr - Ni - Mo steels

3. Presentation of certain experiences within the team technology activities for the production of more important products.

4. Eventual recommendations about the possible way of cooperation with the industry which is to be offered the expert and technological assistance.

5. Eventual by-the-way suggestions, in the course of the personal contacts and the intermediate cooperation, within the jobs concerned with the heat treatment of products, i.e. with the activities of CIATEQ.

The previous work plan has been proposed as a possible mode of professional activities during the mission. Having in mind the objetive conditions in Querétaro, the plan has been changed in certainly details. Namely, work plan has generally been accepted, with exception of points 1 and 2, because of the production nature and factories needs

According to the wishes and plans to get an impression about factories features, which are dealing with production and heat treatment of forgins, has been made a programme of organised visits. Having in mind the mentioned programme it was wxpected to get some informations which are very important for technological activities, especialy in heat treatment of forgings. By means of mentioned, programme has been anticipated for compiling different data as fallows:

a) General informations concerning factory and organization features;
b) Compiling informations concerning technological activities, dipending of the production programs, and specialities of individual factories;
c) Kinds of actual and present technological problems, and usual practice of solving them, depending of nature and complexity of individual problems;
d) Cooperation practice with professional institutions, dipending of the nature of technological problems having in mind the former mentioned, has been planed to visit, in Querétaro, a few factories dealing with forgings production and with forgings machining and heat treatment finalization.

Because of time chortage, the whole plan has not been realized, but it was enough to find out interesting field of activities during the mission.

3. ACTIVITIES FOR BANDED STRUCTURE INTENSITY DECREASING ON FORGINGS PRODUCED FROM STEEL 8620 (AISI)

3.1 GENERAL BACKGROUND AS TO BANDED STRUCTURES PHENOMENON

In accordance with previously defined programme, has been visited a few factories in Querétaro, which have exlusivly been dealth with production and products finalization for the autimotive industry needs.

In one of them, more exactly "Engranes Cónicos", which have been dealt with forgings machining and its final heat treatment, we were informed about very actual banded structures phenomenon at one type of forgings produced from case hardening steel - 8620 (AISI). Because of that phenomenon have been present the troubles at machining procedure. As a matter of fact, in cases of very pronounced banded structures its detrimental influence have had negative consequences on machined surface quality, and in the same time machining tools consumption was increased.

At the opportunity of our visit, has been pronounced a wish for mutual cooperation in order to decrease or eliminate detrimental effect of this phenomenon.

Having in mind personal experience in solving such kind of technological problems at some type of forgines, and in accordance with known data as to possible mechanism of influence in some technological phases of steel processing, the proposal for organized offorts, in order to achieve practical solution, has been accepted.

As a starting point has been used a study which was performed by G. Hour and M. Kormann, from "Centro de Investigación de Batelle en Genebra". In the frame of that study, the banded structures phenomenon was treated complex as to its definition, origin, possibility of its intensity decreasing in some technological phases (from steel production up to final heat treatment), and as well its influence on mechanical and technological properties of forgings and final products.

By study's data as well as in accordance with other literature data (2, 3), the banded structures were defined as material inhomogeniety phenomenon which is usually identified by means of metalography testing, in the shape of ferite bands and ferite with pearlite bands arrangeg in succsesion in the secondary structure of a polished and eatched sample.

The banded structures origin was attributed to chemical analysis inhomegeniety which is usually named segregations. The segregations have its origin in the phase of steel solicification during cooling procedure in the moulds. Namely, the first solidified cristals have a different chemical analysis in comparison with cristals which have solidified later. As a consequence of that, thedendrites which have been formed during steel solidification in moulds, are relative impoverished as to alloying elements. On the contrary of that in interdendritic zones alloying elements are present in elevated contents. The influence combined by these elements has an effect on austenite-ferite-pearlite transformation concerned the phases nature which have been formed in solid state.

Therefore, the banded structures formation have been supported by elements with pronounced segregations during steel procedure solidification, with reference to very litle in solid state difusion, and which have a considerable influence on austenite ferite transformation (Mn, P, Cr, Ni, Mo). Just because of that, at relative slowed down cooling in industrial conditons, takes place the partiicipation of individual phases at different temperature. Namely, in zones with lower contents of alloying elements (on demoritic axis) takes place ferite forming and in the same time carbon is pressed into interdenaritic zones which have a lower temperature of ferite pearlite mixture transformation.

Having in mind the former, logicaly can be concluded that by segregarions elimination can be insured austenite transformation (in all zones) at the same temperature, what could have as a consequence banded structures elimination. Therefore, the first steps in the procedure of bandes structures elimination are indispensably efforts to decrease segregations intensity in the phase of steels production.

The most efficient steels production procedure as to segregations redusing is continous steel casting. There are as well the other more expensive steels production efficient procedures, as ESR, or steels vacuum Casting, but because of its costs, they are out of the question for case hardening steels production.

Therefore, in a lack of continuous steel production posibilities, it is necessarily to undestake efficient technological actions in the phases of clasical steel procedure, as fallows:

- In the preliminary phase of charge making, try to choose the loading material with a higher degree of purity;

- Improvement the temperature conditions and steels casting speed;

- Orientation to the smaller ingots, with adequate mould's configuration;

- Solidifying time in moulds improvement in order to acheive faster ingot's cooling;

Besides of possibilities for segregations intensity reduction in steels production phases, as well there are certainly possibilities in steels processing phases for bandes structures intensity reduction. In accordance with that, at steels processing by hot rolling and furging, with temperatures and hot reductions improvement it is possible to reduce interdendritic distances and as a result to achieve of banded structures intensity reducing.

In the meantime, as the most efficient possibility of banded structures intensity decreasing has been mentioned cooling speed after austenitization, in the phase of heat treatment, which fallows products forging. Therefore, has been tought on isothermal annealing application, with fast cooling from austenite temperature up to isothermal temperature reansformation.

As well as been pointed out a beneficial effect of increased steel

hardenability, as to banded structure intensity decreasing.

In order to be proved the effect of isothermal annealing, have been performed some tests on samples from steel "Locor" (Afnor) with dirrerent cooling speeds from austemitization temperature up to isothermal annealing temperature. By secondary structures comparision after application different cooling speeds it has been established that with rapid cooling speed application the banded structures have disappeared, and by slowly cooling the banded structures have been more pronounced. In accordance with that, by means of properly cooling speeds selection after austenitization, it is possible the banded structures intensity cut down up to a minimum. Naturally, for every steel grade there is a tipical critical range of cooling speeds, and as well the most convenient isothermal annealing temperature. Just because of that it is indispensably to be acquainted with TTT diagrams for each steel grade, and by means of a few tests ot is possible to establish the best isothermal annealing procedure.

Besides the previously mentioned, it has been considered the banded structures influence on mechanical an technological forgings properties In the meantime, the results quantification was not simply because of mixed up the bandes structures and non-metalic inclusions influence.

However, it was very obvious the banded structures harmful influence in the machining procedure of different details, as well as to materials heteroginiety properties, especially ductile properties in the transversal direction.

In comparison with the logitudinal direction, ductile properties were reduced for about 8 times. In any case, such extent of ductility differences can have very detrimental effect on service life in practical for mani important items.

3.2 TESTING PROGRAMME-PREPARATION IN SEMI-INDUSTRIAL CONDITIONS

Having in mind the previously mentioned literature data (1.2) as well as

personal experience, has been concluded that is indispensably to undertake efforts in all technological phases in order to produce steel with minimum of segregations, with reference to decrease the banded structures intensity.

In the meantime, when forgines are already produced with present banded structures phenomenon, then there is left a most efficient way to carry out an intervuntion by means of isothermal annealing application.

Having in mind that in forgings production, which have been finalized by "Engranes Cónicos" participate steels producer, forgines producer and forgings beneficiary (Engranes Cónicos), has been proposed to organize a team work. The participants of team should be compounded from the representatives of mentioned factories toghether with representative of CIATEQ, whose duty should be participation and all the team work coordination. In accordance with that has been offered adequate working programme as has been described in the point 4.3 which fallows.

3.3 THE CONCEPT PROPOSAL OF PRACTICAL TESTS IN ORDER TO ELIMINATE PHENOMENON OF BANDES STRUCTURE IN FORGED PIECES

1. Evaluation present phenomenon features, and at the same time, the previous technology history, as follows:

   a) Chemical analysis of heats;
   b) The starting ingot's dimensions
   c) Dimensions of starting billets (or blooms) and corresponding hot deformation rate;
   d) Forging temperature conditions, number of reheat treatments, and hot deformation rate;
   e) Heat treatment conditions (heating, austemitization, holding time, cooling and lot's features;

2. Sanples selection for "semiindustrial" tests:

   a) Selection of needful number of samples;
   b) Adequate samples marking;
   c) On the selected samples hardness measuring;
   d) Mechanical testing of selected samples (tensile test and thoughness);
   e) On each sample estimate the starting state of the secondary structure, take a photo, and estimate the contents of non metallic inclusions;
   f) The secondary structure has to be identified from surface to the center of piece;

3. Estimate holding times, in different cooling means, having in mind the isothermal temperature of transformation,

4. Parameter selection for austenitization, cooling and isothermal annealing performance;

5. Organize the method of control, in order to realize the prescribed variables of heat theatment.

6. Tests realization in "Semiindustrial" conditions

7. After heat treatment performing, for all types of variables, to carry out (on sample pieces) hardness measuring, the results comparison, for each variable of cooling, having in mind the starting state of the secondary structure.

8. Heat treatment proposal, for industrial lot, and test realization in industrial conditions,

9. On the accidentally selected samples perform hardness testing mechanical testing and secondary structure testing.

10. The all results evaluation, and making optimal heat treatment prescription;

11. Permanent method of control definition, in order to realize the prescribed heat treatment.

3.3.1 ADDITIONAL EXPLANATION AS TO CONCEPT REALIZATION

In accordance with proposed text of the concept, the most important phases are samples selection and its starting quality estimation, isothermal annealing variables selection and its realization, and forgings testing after different variables application.

As a matter of fact the central activities in frame of the concept have been planed on isothermal annealing application.

The essence of isothermal annealing is rapid cooling application from the austenization temperature up to the isothermal annealing temperature.

In order to clear up activities described in points three and four (in the text of Concept) there is a need to point out data as fallows:

- TTT isothermal diagram for steels in question;
- Maximal diameter for individual forgings type;
- Decision as to cooling means selection,

By means of TTT isothermal diagrams could be selected the austenization temperature and optimal isothermal annealing temperature.

In the same time, for definite forgings diameter, having in mind selected cooling means and isothermal annealing temperature, could be determinated cooling parameter. Namely, by means of diagrams (1) could be estimated needful cooling time for piece core to be cooled to the isothermal annealing temperature.

In order to realize complete variables of isothermal annealing, the practical orientation procedure could be as fallows:

a) Heating to the austenitization temperature, respecting "The Carbon Coefficient" and furnace heating possibilities;

b) Holding time on austenitization temperature, with respecting dimen-

sion of forgings,

c) Cooling in selected means, in accordance with previously selected parameters (by means with data in hand books);

d) After cooling, as quickly as possible, put the pieces in furnace which is preheated on isothermal annealing temperature.

e) Holding time on isothermal temperature should be 2 - 4 hours, depending from the forgings diameter;

f) After holding time on isothermal temperature, continue with forgings cooling on still air.

g) Testing performing in accordance with point 2 of the concept (c, d, e, f), and results evaluation;

f) After that could be continued with activities described in the concept, as well as in points 8, 9, 10 and 11.

4. RECOMENDATION AS TO ACTIVITIES IMPORTANT FOR PRODUCTS HEAT TREATMENT PRACTICE

4.1 HARDENABILITY RESEARCH OF CASE HARDENING STEELS

Having in mind intention to select some interesting fields of research activities in next period, and in accordance with impressions in having been visited factories and consultations with representatives of CIATEQ has been concluded that is necesarily to select something in conection with products treatment for automotive industry needs.

In the same time respecting the fact that on the products for automotive industry have very often been applied case hardening heat treatment procedures, has been appreciated that could be vey useful to initiate a project realization as to subject of case hardening steels hardenability research.

Namely, in recent times [3, 4, 5, 6, 7] has been overcome a practice about surface and core hardenability testing, and in accordance with received results has been fallowed steels selection for different kinds of application.

In conection with that, now it is not enough on the base of core hardenability to form a judgement as to steel applicability.

In accordance with the former, the steels with entirely identical core hardenability can have very different case hardened layer hardenability, what is very important for decision making as to steels applicability.

The details as to possibilities in the field of case hardening steels hardenability research have been presented to the CIATEQ's representarive, who was in charge of activities as to heat treatments and queality products improvements. By this oportunity will not be presented all the details of case hardening steels hardenability research, but will be pointed out the possibly results and of its possessing benefits.

Therefore, by means of case hardening steels hardenability research, in dependence from case hardening procedure, especially at gas carburizing procedure (direct or indirect hardening) could be determinated the features al fallows:

- Carburizing curve in coordinates, carbon contents and surface distance;
- Jominy curves of completely research case hardening steels hardenability for different carbon contents in dependence from depth of case hardened layer;
- Isohardness numograms with possibilities of simultaneously presentation the most important case hardening steels features;

Carburizing curves and Jominy curves of completely research case hardening steels hardenability are entirely known and there is no need to give some specialy explinations, but some data as to isohardness nomograms elaborarion are indispensably.

Namely, becausxe the results presentation of case hardened layer has become immensely, with reference to Jominy curves at a larger number of diferent carbon contents levels, has been developed another methods of results presentation, One of them is isohardness nomogram.

In accordance with the previously mentioned, from Jominy curves data for different carbon contents (on orinate) and distance from quenched end of Jominy test (on abscise), can be constructed curves of constant hardness- curves of isohardnesses.

The monograms for isohardnesses presentation are set up on the basis of suppositions as fallows:

- On equally distances from quenched end, the cooling speeds are equeally;
- Of definite depth of case hardened layer, the carbon contents is constant, what is due to constant case hardening conditions;

These suppositions make possible to study case hardened layer hardenability by subsequently method:

- Hardness measuring along with Jominy test, on the individualy carbon level constants, and fallowing hardness dependence from cooling speeds on individualy depth of case hardened layer;

- At individually distances from quenched end of case hardened test can be estimated hardness dependence from carbon contents at constant cooling speed;

Isohardness nomogram represents a complex review of hardenability features for complete carbon and hardness range wich can be achieved.

Consecuently by that way can be presented very well the feutures of individually steels, which are essentially for steels applicability.

All the isohardness nomograms represent a common, with reference to isohardness curves which show a maximum Jonimy distance from quenched end at some carbon level which is typical for definite steel grade. This tipical carbon contents which belongs to the maximum of Jominy distance from quenched end, is mostly for all isohardness curves the same carbon contents, which belongs to the isohardness curve maximum, is being considered as the most important steel feature, in accordance with knowledge of case hardened layer hardenability.

This maximum simultaneously define the carbon contents which make possible to achieve entirely martensitic structure on case hardened surface at a minimum cooling speed.

From isohardness nomograms can be obtained very important information as to right carbon contents on case hardened surface in order to achieve hardness and hardenability maximum for case hardened details from definite steel grade.

By means of case hardening steels research can be get the anwers for practice as fallows:

a) What carbon contents will correspond to the hardness maximum at different cooling speeds;

b) What carbon gradient will be necessary in order to achieve the indispensable hardness gradient from surface up to core of a case hardened piece;

c) What is the difference among individualy steel grades, at direct and indirect hardening procedure application;

d) What is the best steel grade as to achieving the needed carbon and hardness gradients;

e) How much has to be case hardened layer depth, in order to achieve definite hardness level at a given carbon gradient

f) What is the alloying elements influence in steels, on hardenability in core and in case hardened layer, and what is the influence of chemical analysis oscillations;

In accordance with previously mentioned, can be concluded that is usefully for steel producer to represents all the steel features, and as well for steels beneficiary to have all data on disposal, in order to be able for properly technology priscribing.

Having in mind that, could be very usefully a project realization as to hardening steels hardenability research.

4.2 POSSIBILITIES OF CASE HARDENING STEELS MODIFICATION BY BORON MICROALLOYING APPLICATION

Larger part of Querétaro industry is dealing with production and forging finalization, which are produced from case hardening steels

In the meantime, at these steel grades are present some problems conected with hardenability and as well with its production costs. Just because of that there are actual ideas about some steel grades modification, by means of micro-alloying application. When as in this field in many cases has overcome Boron Micro-Alloying (which has not been applicated in México), there are wishes and plans, in CIATEQ, for practical tests initiation.

Having in mind useful practice of previous results evaluation in other factories or institutions, by this opportunity can be pointed out definite research and industrial results which have been achieved in Yugoslavia, more exactly in Zenica/Mining and Metallurgical Combine -RMK in Zenica and Mutallurgical INstitute "Hasan BrkiĆ" (Zenica). The results have been realized on some case hardening steel grades destinated for defined gears types used in automotive industry.

In accordance with previously mentioned, should not be neglected the possibility of mutual efforts in steels production and its properties verification.

Naturally, this variant should previously be considered respecting the interest both of partners, and after that could be concluded eventual arraignment, concerned of mutual professional activities.

5. SOME ASPECTS ABOUT RESEARCH POSSIBILITIES IN INDUSTRY

5.1 GENERAL BACKGROUND

In accordance with the increasing needs of an industry, it can be necessarily to set up an institute of industrial type. The setting up such type of institutions is especially actual when an industry cannot fallow market demands and own development, without intensive and permanent use of scientific knowledges and their transformations in practical solutions of some technological problems.

At the very beginning of institution's estimation there are usualy a lack of experienced staff and research equipment, as well as lack of the institution's defined development programme.

It is understandable at the work beginning, because the principal activities are concentrated in attempts to solve some important problems in industry, and by means of that acquire a respectively confidence from industry. Naturally, this is the most complex institution's existance period, that is why are needed great skilfulness and high level of habilities in order to choose the best working programme, efficient working methodology, and institution's development programme.

In order to present some base ideas as a possible contribution to the further CIATEQ's organization and development, at this opportunity will be presented, in a free interpretation, some experiences in Zenica (8) Yugoslavia, concerned cooperation between metallurgical institute "Hasan Brkić" Zenica and Mining and Metallurgical Comibine (RMK) Zenica.

Namely, the accepted attitude has been based on some hippothesis which will be reported in the text which fallows.

In accordance with the former, there is a supposition that in the sphere of research activities can be more kind of motives, but the most often is economical motive, which, from research activi-

ties demands and expects as well, solving of actual technological problems. In the frame of previous mentioned, there are grades of complexities for research activities as fallows:

a) Adaptation: In specific conditions, known solution application for which is wanted certainly adaptation, but essentially the solution is unchanged;

b) Modification: In cases when local conditiones demand considerable adaptation on concrete technological, economical and social conditions;

c) Development Research: A grade more, in comparision with modification, where is present effort to solve a concrete probleme by means of present knowledge fund;

d) Applied research: Solving of some concrete problems, by means of original composing of present and provisioned new knowledges which are wanted in order to realize inventions aims;

e) Fundamental Research: In this type of research participate base scientific disciplines as ar mathematics, physics, chemistry, etc.;

Depending from the technology level, the participation each of previously mentioned researches, are different. Namely, the most developed countries are orientated on new solutions discovering. In research activities at these countries dominate applied and fundamental researches.

On the other hand, under-developed countries have dominate participation of adaptation and modification researches. For there countries is priority to use known solutions which are already proved. Too much participation of fundamental research in conditions of a low grade of development can be in contradiction with actual indus-

try needs, and in such cases the research function will be byond of expected contributions. This principle is necessarily to keep in mind in the phase of programme making, especially in accordance with actually factory needs, which will be the potential service beneficiaries. In the context of the former it is worth to mention that the products research is a very interesting field of activities for industrial regions with a lack of financial resources for equipping of new plants and new technology.

Products research one can to understand as attempts to improve quality of present products, as well as to create new products in conditions of available facilities. This type of research stands for a tipical instance where an underdeveloped industry can improve own efficiency, by means of a higher products quality level, in spite of the fact of a low rate of productivity.

5.1.1 RESEARCH PROGRAMME ESTABLISHMENT

In order to be able to establish more detailed working programme of a research institution, it is indispensably to know present and future production plans of the factories which are potential services beneficiaries. In the same time, it is necessarily to study what kind of research activities could be actual, and in accordance with the available data estimate institution's research concept.

In the meantime, as to programmes of individual research tasks, in any case is indispensably to prepare reviews for technology ranges as are, for instance, materials economy, fuel economy, time economy quality control and anothers possibly ranges.

At these opportunity, the importance of quality control will be pointed out, because of its specific position as a central point where are present all informations concerned of raw materials, semiproducts and final products quality, as well as the completely process quality state. By means of informations data there are possibilities to define many tasks whose solutions demands research

activities.

But for an efficient research work programming it is necessarily to have some more data. Namely, it is very important to have informations concerned the technology state at the other producers relevant for the actual problems in question. Neglecting this aproach could lead to the partial solutions, what finely, can have negative consequences on the products quality.

Having in mind the former, one can understand that research programme establishment represents an evaluation of actual problems in the factories potential services beneficiaries.

In the context of mentioned, it is necessarily to perform a list of actual problems. Eventualy numerous problems do not represent a bad technology state in the factories, but on the country a pronounced decision to do more rapid technology progress.

When the list, of actual tasks, has been estimated, as next phase is the priorities definition depending of actual needs in individual factories. After that, it is necessarily for the priorities which have been chose, to prepare a contract proposal. After corresponding considerations the contract can be accepted as a document with defined responsabilities both of partners, as to details of financial, termination and other conditions important for project realization.

5.1.2 RESEARCH PROGRAMME REALIZATION

Research programme realization represents an essence of scientific research activities. This type of professional work is usualy compound from two componcnts:

- Speculative;
- Experimental;

Speculative work, as a matter of fact, is a thoughtful research activity, where, by means of determinated data and informations,

there are possibilities to find out new combinations, or to create a new solution. The usually auxiliary means at this work are professional literature, writing table, drawing set and computation means where especially there are almost indefinite number of possible combinations by computer using.

Regardless on speculative research possibilities the really scientific research work cannot be imagined without practical experiments. The experiments significance is larger, when the tested phenomenon is less known. In the sphere of experiments is very important to fallow rule, as litle as possible experiments, and try to receive as much as possible informations.

In accordance with that, there are possibilities of laboratory and semi-industrial experiments where one can receive much useful results, with spending no much of tested material.

Industrial experiments should be performed, when the esperimental risk is put down up to the minimum.

In order to be capable to perform really work research, a research institution needs experienced staff and research equipment. The contemporary method for solving technological problems mostly has a multidisciplinary character, and that is why a project realization is being performed by professional teams, compounded from professionals of different specialities, depending from the nature of concrete tasks.

The benefits of such working teams are possibilities to study some problems more complex and in details, what is usualy beyond the means of an individual. In such working teams, the most important part is how to coordinate the work of all participants and in the same time direct them to the best solution of defined task. Because of that, the project manager has to have wide technology knowledges range, and indispensable comunications hability. Having in mind that, he has to be able to interpret different results in individual subsectors of the project, in order to realize the best project solution.

5.1.3 RESEARCH RESULTS APPLICATION

Especially considerable phase of research work represents realized results application. Usually is expected from the research ordered to be the most responsible for offered solutions applications. In the meantime, in practice can exist different situations as fallows:

- The application of offered solution, with delay without reason;

- Because of new technology introduction, with delay of offered solution application;

- To be modified the offered solution, what can have decreasing influence on the previous research efforts;

Just because of that, it is necessarily for the project manager to be responsible for project application. This is especially important in the research phase, having in mind manager's duty to find out the best in practice feasible solution.

In accordance with that, of special importance is the cooperation practice with professionals in factories which are dealing with problems in question, to be included in project realization. By that way will be easier to overcome actual problem of habits, which are present at every new solution application and can be a barrier of realization all possible benefits.

Besides of that the professionals participation, which are employed in production, is of great benefit for them, because taking part in solving some definite problems they take adventage of knowledge and experience enrichment. Having in mind that, there is a chance to estimate better possibilities for research staff selection and to build up the research institution potential.

5.2 WORKING METHOD PROPOSAL FOR CIATEQ

Having in mind the base points of view described in PT. 6.1, as well as the endeavours for CIATEQ to be a research institution with adequate reputation, it is necesarily, in the very nearly future, to undertake the following:

1) By means of complex and detailed analysis, it is necesarily to get acquinted with the present and future production's programmes of factories which are the services beneficiaries.

   In accordance with the programmes contents, try to define the main fields of CIATEQ's research activities.

2) In order to estimate research plan for 1982 year, in cooperation with the factories professionals in the state Querétaro, it is necessarily to prepare a list of actual technological and other problems.

   From this list select the priorities, and study which problems could be solved in CIATEQ's Arraingement.

3) For each selected problem, which can be solved in CIATEQ's arrangement, it is necessarily to prepare the "Program Research Proposal" with the contents as fallows:

   - The actual problem's description;
   - Possible way of problem's solution, with description the base phases of realization;
   - Necessary testing material and eventualy other institution's services;
   - The price of project realization;
   - Necessary stuff number with defined specialities;
   - The date of project realization;

   The offered "Research Programme Proposal" has to be considered with the service beneficiary, and after that can be a contract concluded. In the contract has to be defined the responsabili-

lities both of partners, as to details described in the "Research Programme".

4) Each project realization to carry out by means of "Specialist Team" which has to be compounded from specialist in factories which are the services beneficiaries, from CIATEQ representatives and of the specialists from the another institutions or factories.

The jobs bearer in each project is "The Project Manager". In accordance with its responsabilities, "The Project Manager" has to possess a wide technical knowledges range as well as comunications abilities, to be capable for succsessfully project realization.

Because of activities nature, "The Project Manager" must be representative of CIATEQ. In the meantime, having in mind very limited number of experinced professionals in CIATEQ, it is neccesarily to consider eventually possibility, for project manager, to be from the another institution, but only in favour of CIATEQ.

5) In order to be capable for the project rhythm and contents realization fallowing, it is necessarily to organize an "Advisers Team" compounded from experienced managers in CIATEQ and factories services beneficiaries. In the phase of the project realization, the base the "Team's" task is to carry out permanent supervision and consultations in order to insure the correct professional level by the project offered solution. Besides that the "Team", as well, is responsible for project review and appreciation as to the projects in practice applicability.

6) For the adequate work research efficiency of special importance is the level and mode of payments for all in the project realization participants. Having in mind that it is indispensably to determinate a salary, for all in the project realization participants, in accordance with grade of working and professional

contribution. This approach of professionals payment represents an additional incentive for professionals motivation as to taking part in the individual projects realization that is in the same time a very profitable investment, because of realy possibilities to insure an extended professionals number, which are dealing with work research.

By this way, the professionals which were taking part in the solving some technological problems, could take adventage of enrichment their knowledges and experiences.

As a consequence, that can be very useful for their everyday work

Besides that, the professionally qualified staff in industry will be initiators of many jobs and projects which will represent the existence future of CIATEQ.

This kind of working method in the same time will contribute to CIATEQ's popularization and to insure much better possibilities for experienced research staff selection, which is already proved in research activities.

7) In a lack of research equipment and necessaryly staff experienced number, but having in mind the CIATEQ's wishes to be able to offer as much as possible services to the industry, it is indispensably to undertake intensive activities in order to make the acquaintance with activities and possibilities of the other institutions.

This is of special importance for the properly orientation in cases when are necessarily the staff and equipment from the another institutions. Naturally, in the total project quotation should be included the part as to the services costs.

8) As a final aim in research institution's physiognomy estimation one can understand professional staff and research equipment possesion.

But, in both cases it is necessarily to act succesive and cautiosly. Namely, the research staff should be brought from industry, but having in mind that staff formation procedure takes the time, there is no possibility in short time to insure needed staff.

As to research equipment acquisition it is also needed to act cauticusly, until the actualy and realy needs have been completed Namely, it is necessarily to study as much as posible what king of equipment is available in different factories CIATEQ's potentialy services beneficiaries. In accordance with that try to estimate its utilizing rate and eventualy possibility to use for CIATEQ's needs.

6. SUMMARY

In accordance with data described in points 3, 4 and 5, during the mission have been undertaken efforts which have been concentrated on ranges as fallows:

- Professional efforts in order to eliminate the banded structures phenomenon, which have been actual on forgings produced from case hardening steel 8620 (AISI);

- Considerations work research possibilities in order to intensify efficiency of CIATEQ;

- Recommendations performing about professional activities in the future, which are important for products heat treatment practice.

As to previously mentioned, has been considered the banded structures phenomenon (Pt. 3) in many aspects, and in the sometime has been prepared and offered the concept for research and banded structures elimination. Besides that have been established immediate relations with factories, and as a consequence have been pronounced its wishes for permanent cooperation by methodology of a team work.

With regard to CIATEQ as a young institution have been appreciated that should be useful to sugest some attitudes about cooperation possibilities with industry. In accordance with that has been proposed corresponding working methodology for CIATEQ.

With regar to a lack of experienced staff and research equipment, but respecting the wishes for CIATEQ to become, as soon as possible, an efficient institution, have been sugested some project realizations (Pt. 5). These projects relate to case hardening steels hardenability research and as well as to its modification by means of Boron Microalloying application. The projects are very atractive because of possibilities of its realization by means of anothers institutions and factories equipment.

7. ACKNOWLEDGMENTS

The author feels oblied to express his deepest thanks to UNIDO for supporting candidature about the selection for an Expert in Thermal Treatment in Querétaro, México.

In the same time as well, many thanks to CONACyT and CIATEQ (México) for offered confidence, help and hospitality during the mission realization.

Besides of mentioned should be pointed out that it was a useful opportunity for professional experiences exchange, and immediately has been taken adventage of making the acquaintance in order to continue the mutual cooperation in the future.

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EXPLINATION:

TT - Taitement Thermique

HTM - Harterei Technische Mitteilungen

MiTOM - Metalovedenie i termiceskaja obrabotka metalov

9. SUPPLEMENT

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
UNIDO

22 August 1980

PROJECT IN MEXICO

JOB DESCRIPTION

DP/MEX/77/008/11-13/C/31.3.J

Post Title	Expert in Thermal Treatment
Duration	One month
Date required	As soon as possible
Duty station	Querétaro
Duties	In co-operation with the Consejo Nacional de Ciencia y Tecnología (CONACyT), the expert will generally assist the Centro de Investigación y Asistencia Técnica del Estado de Querétaro (CIATEQ) and, more particularly, will advise them on the more important aspects of heat treatment normally used in industry. Specifically, the expert is expected to:

1. Organise at least one seminar and/or short course on the relevant aspects of heat treatment, dealing especially with modern methods and current trends, levels of production, standards and quality control;

2. Assist CIATEQ in handling specific consulting and advisoty request received from industry in this field;

3. Make specific recommendations to CIATEQ concerning its development plans and technical services for industry related to thermal treatment;

4. Advise CIATEQ on training programmes for its technical personnel and recommend institutions in which these programmes could be carried out;

5. Provided bibliographical and documentary material on the subject of thermal treatment for the information until of CIATEQ.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Goverment on further action which might be taken.

QUALIFICATIONS Extensive technical and industrial experience in the field of thermal treatment; ability to organise and conduct seminars and courses.

LANGUAGE English; knowledge of Spanish essential

BACKGROUND INFORMATION CIATEQ has only recently been included in the project being carried out at the Centros Regionales de Investigación y Asistencia Tecnológica a la Industria (CRIAT). Until now, it has won the confidence of the metalworking industry in Querétaro which is the centre of its activities. In order to assist this Centre to get off the ground and to demonstrate its potential use, a series of short-term experts should be provided to guide CIATEQ and to offer practical instruction to the industry in the main subsectors or problem areas of metalworking, one of which is thermal treatment.

CANDIDATES REQUESTED BY 17 OCTOBER 1980

Applications and communications regarding this Job Description should be send to:

Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, VIENNA INTERNATIONAL CENTRE, P.O. Box 300, Vienna, Austria

80-42733