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INTEGRATED INFORMATIONAL SYSTEM FOR AN ALUMINUM SMELTER COMPANY - ISAL

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The organization of aluminum production process is complex and multifaceted task, which necessitates handling and control of huge amount of information (composition of casting, content of the pots, energy consumption, electric parameters, chemical composition analysis, etc.). The need to ensure stable access to all the relevant data necessitated development of Integrated informational system for logistic support for production of anodes, electrolysis and aluminum smelter. This paper describes basic design and structure of this Integrated Informational System, developed for the needs of Aluminum Smelter Company "Aluminij d. d." Mostar.

Key words: *aluminum production, factory informational system, informational subsystem in aluminum production*

Integrirani informacijski sustav tvornice aluminija - ISAL. Upravljanje složenim procesom proizvodnje aluminija zahtjeva raspolaganje velikom količinom podataka (sastav taline, sadržaj lonaca, utrošak energije, električni parametri, analize kemijskog sastava i dr.). Potreba za brzim pristupom podacima zahtijevala je izgradnju integralnog informacijskog sustava za logističku podršku poslovima izrade anoda, elektrolize i proizvodnje aluminija. U radu je opisana osnovna struktura Integralnog informacijskog sustava razvijenog za poduzeće Aluminij d. d. Mostar.

Ključne riječi: *proizvodnja aluminija, informacijski sustav poduzeća, informacijski podsustav proizvodnje aluminija*

INTRODUCTION

Development of aluminum industry in Mostar dates as far back as 1981. Next to alumina factory, a modern aluminum factory was constructed. The scope of work of the factory encompasses production of raw, baked and cast anodes, electrolysis with transformer station, smelter and waste gas treatment. Designed and installed capacity amounts to 92 000 tones annually of primary aluminum and aluminum alloys with 99.9 % of purity in the form of ingots, T-ingots, blocks, logs and wire. Figure 1. presents diagram of aluminum production.

The factory has fully automated production line with annual capacity of 130 000 tones of raw and 60 000 tones of baked anodes. The basic raw material for production of anodes are petrol coke and resin, which are crushed, milled, classified, mixed, heated and pressed so as to form raw anodes. After process of baking, anodes are cast with liquid iron, joined with aluminum bars, and as such, delivered to electrolysis and the storage area. Besides production of anodes for needs of their own electrolysis, anodes are also produced for other aluminum factories.

The electrolysis separates aluminum from aluminous oxide raw material in one electrolytic series consisting of 256 electrolytic cells by Hall Heroult technology. The cells are of closed design with side protrusion and 140 kA electric current.

Electrolysis is equipped with modern devices for dry and wet treatment of anode gases, which provides effective environment pollution protection. Dry gas treatment proceeds by filtering of reactive aluminous raw material, while wet purification ensues by process of dissolution and precipitation in water.

Molten aluminum is delivered from electrolysis to smelter in special vehicles, undergoes metallurgical treatment in the furnace, is being alloyed and cast in suitable forms.

The smelter is equipped with devices for molten metal control (quant meter), "Alpur" and "Sinf" devices for purification of molten metal (degasification), furnace for homogenization of logs and product cutting, packing and delivery appliances.

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The increased need for on time and accurate information in operation of complicated electrolytic processes, production of anodes and aluminum smelter process set off the need for development of Integrated Informational System of the company "Aluminij d. d." Mostar.

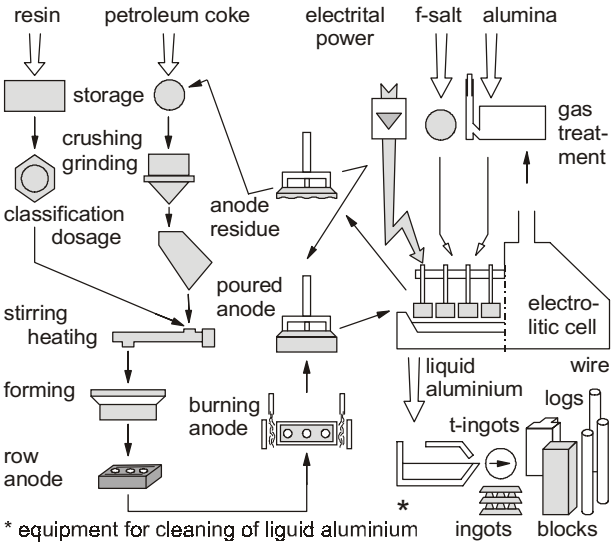

Figure 1. **Aluminum production diagram**
Slika 1. **Shema proizvodnje aluminija**

Management of company "Aluminij d. d." predefined ISAL basic requirements as follows:

- organization of all relevant information required for management of fundamental functions of company sectors: sales and commercial department, laboratory, quality assurance, electrolytic production department, anode production, aluminum smelter, waste gases treatment, material and spare parts purchase, maintenance of the plant and accountancy,
- development of data processing program and its interface with the environment tailored to the needs of users and management,
- design and development of local ISAL network,
- connection of ISAL with digital reading device ("quant meter"),
- set up of ISAL system within time period of 4 - 6 months,
- build up of user oriented system on relational data base.

After analysis of proposals for installation of world leading integrated informational system for production companies (SAP, Bann, etc), Croatian company "Informatički inženjering - ININ d. o. o. from Slavonski Brod was chosen to do the job.

STRUCTURE OF INTEGRATED INFORMATIONAL SYSTEM FOR ALUMINUM PRODUCTION - ISAL

Figure 2. shows ISAL structure:

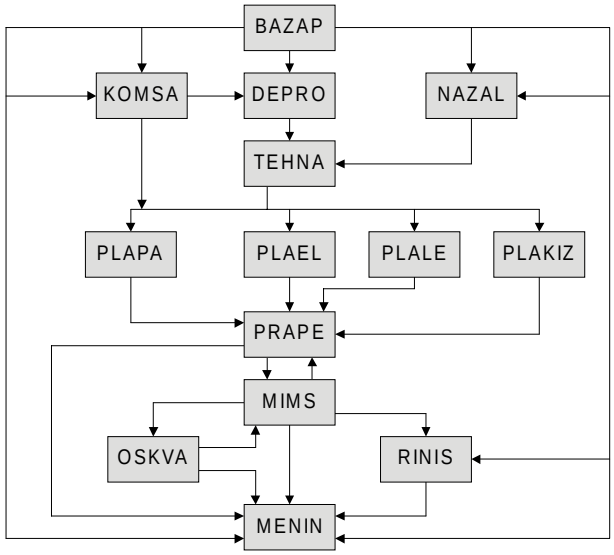

Figure 2. **IIS Aluminum subsystems**
Slika 2. **Podsustavi IIS Aluminij**

Integrated informational system consists of the following subsystems:

BAZAP - common data base *contains data for other IIS ALUMINIJ subsystems:*

- business partner information (customers, vendors, subsuppliers …),
- information on enterprise, organizational structure of the entire company and organizational structure of single factory units,
- basic information on employees and their families,
- automatic assignment of identification numbers to coded notions with and option of defining of already engaged codes,
- program for elaboration of categorization system for classification of characteristic features of the same category,
- glossary for automatic description of business and technical notions for the purpose of easier understanding by users,
- labor force codes with their access rights to data and programs contained in ISAL,
- manager Work Planning,
- instructions for operation of ISAL.

KOMSA - subsystem: commercial and calculation subsystem contains information on customers needs , product or service prices, issues production orders or instructions for preparation of products for delivery and generates on the basis of delivery notes invoices and supervise invoicing and realization of payments on the part of customers. This subsystem fulfills specific requirements of the sales and commercial departments of single factories. Besides price calculation module, specific for products of diverse

plants, this subsystem controls competitors' prices on domestic and world markets. Separate module in this subsystem represents module for export and import supervision, customs declarations and clearance and cost evidence for imported components.

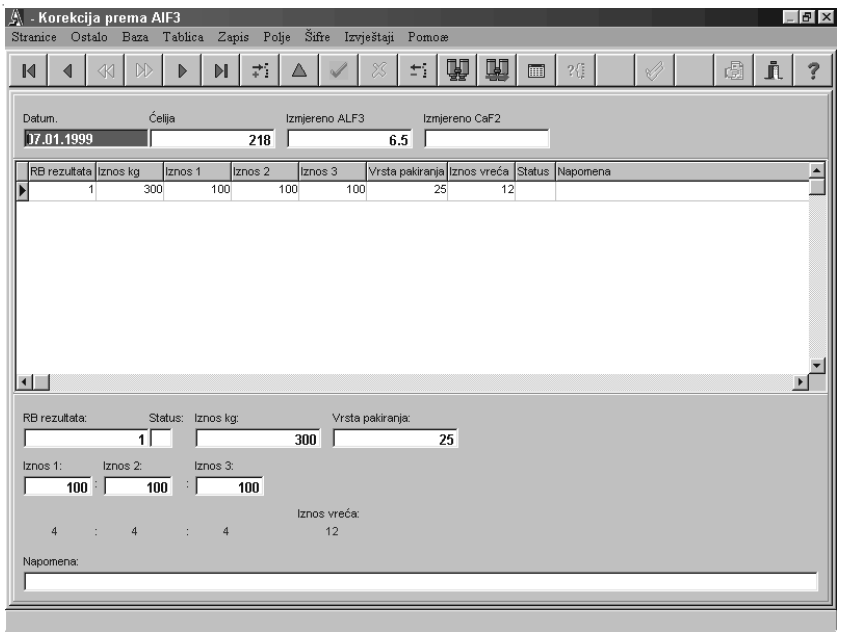

Figure 3. **Calculation of acidity additive**
Slika 3. **Proračun dodatka za kiselost**

NAZAL - purchase and inventory subsystem *contains information on stocked materials, additives, spare parts and components.*

Surveys and reports generated by NAZAL include:

- material and spare part inventory status,
- minimal, maximal and signaling material and spare part quantities,
- MRP (material requirement plan) for spare part dynamics,
- list of obsolete spare parts,
- material and spare part flow for certain time periods,
- material and spare part inventory,
- required and ordered spare parts and materials,
- realization of orders (required, contracted, stocked).

DEPRO - subsystem: product definition and its structure (recipe) contains structure description of each products, raw materials, additives added in single production stages and ratios involved in product and recipes for single product categories.

TEHNA - subsystem: production technology contains information and norms for performance of single technological operation, required tools, appliances and molds for carrying out of these technological operations.

PLAPA - subsystem: production planning in anode factory enables the issue of production plan for anode factory, and the plan for all required resources for realization of the planned production (incoming material, additives and energy requirements).

PLAEL - subsystem: production planning in electrolysis factory contains information and programs enabling planning of production in electrolysis factory with all the required production resources (incoming materials, energy consumption) [3]. During development of planning system data organisation has been established to develop and apply genetic algorithm for production planning [4-6].

PLALE - subsystem: production planning in the smelter contains data and programs enabling production stage planning in smelter according to assortment of products together with necessary resources (molds, additives, incoming raw material).

PLAKIZ - subsystem: production planning in control and protection contains data and programs enabling pro-

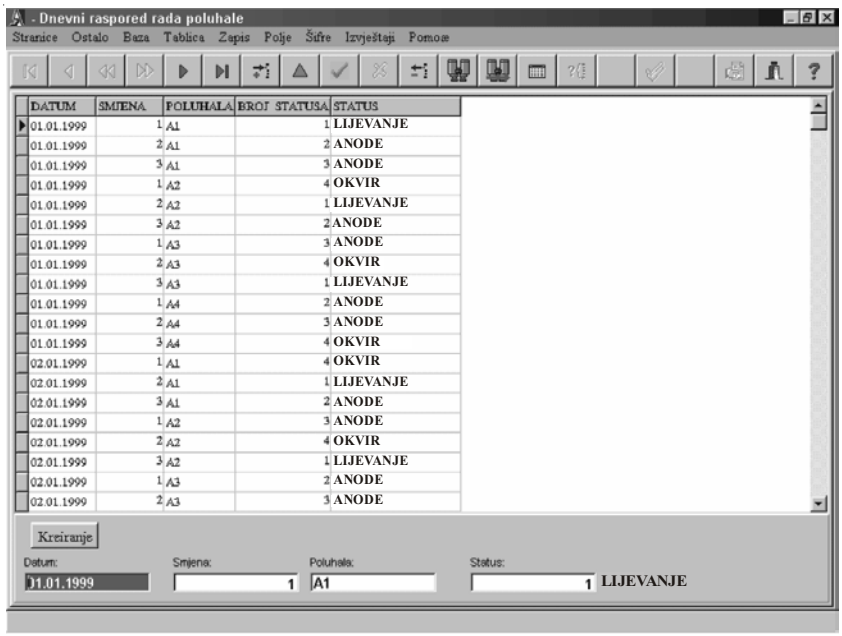

Figure 4. **Entry of daily production indices**
Slika 4. **Unos dnevnih pokazatelja rada faza**

duction planning (dry and wet waste gas treatment) and necessary resources in the enterprise. PLAKIZ enables acquirement of reports and survey of the planned production together with the expected financial effects out of planned production (fund inflow and outflow).

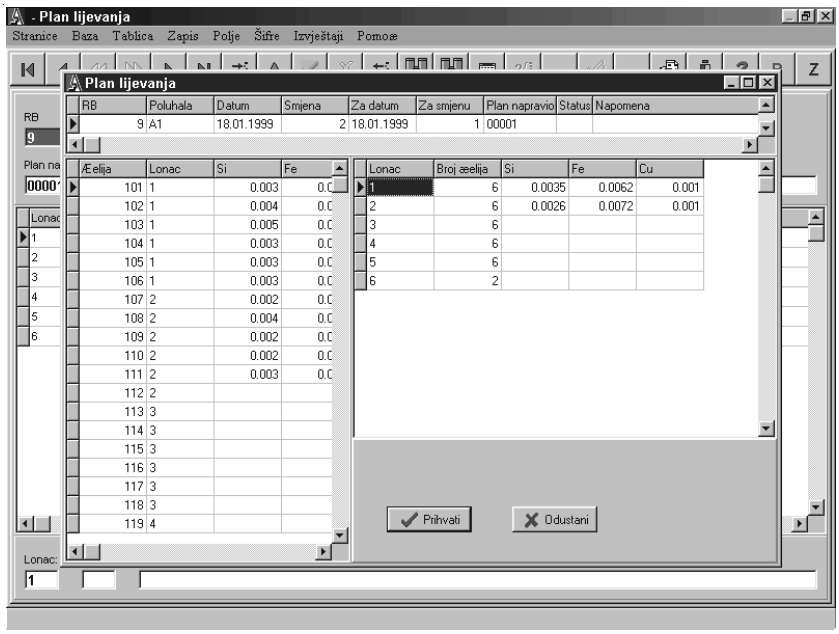

Figure 5. **Work out of melting schedule**
Slika 5. **Izrada plana lijevanja**

PRAPE - subsystem: production monitoring contains data on realization of shift plans and work of productive labor force. Information on manufactured quantities in single production stages are read from process computers, wherever they exist in the process line, or by entry of quantities on the part of operative production. The supervisors oversee work of the shift labor force by entering information into subsystem PRAPE.

MIMS - subsystem: production line and equipment maintenance includes technical and exploitation information on machines and equipment, information needed for work out and tracking of preventive maintenance plans and control inspection of production equipment and history of behavior of machines in operation, work orders for removal of defects and standstills, as well as plans and results for performance of planned repairs. Data organization at subsystem of maintenance has been created to satisfy requirements of developing and application of system for prediction of failures based on neuron networks [7-9].

OSKVE - subsystem: quality assurance contains information and programs, which track results of laboratory tests in single production stages and quality of final products. It supervises also all quality deviation, categorized by causes and costs and customer complaints. Separate module of OSKVE represents laboratory planning and monitoring, depending on requirements of production process.

RINIS - subsystem: accountancy contains information and programs for control and processing of accountancy data. Specific quality of RINIS lies in the fact that it issues accountancy reports for unit factories for the purpose of analytical control and cost control in each single production unit, as well as for the complete plant "Aluminij d. d.".

MENIN - subsystem: management enables the management board and heads of department to carry out continuous control of business and production process. This subsystem supervises realization of plans for each factory and production stage and realization of plans for preparation and provision of production resources. This subsystem enables managers to oversee accuracy and precision of their collaborators. This subsystem

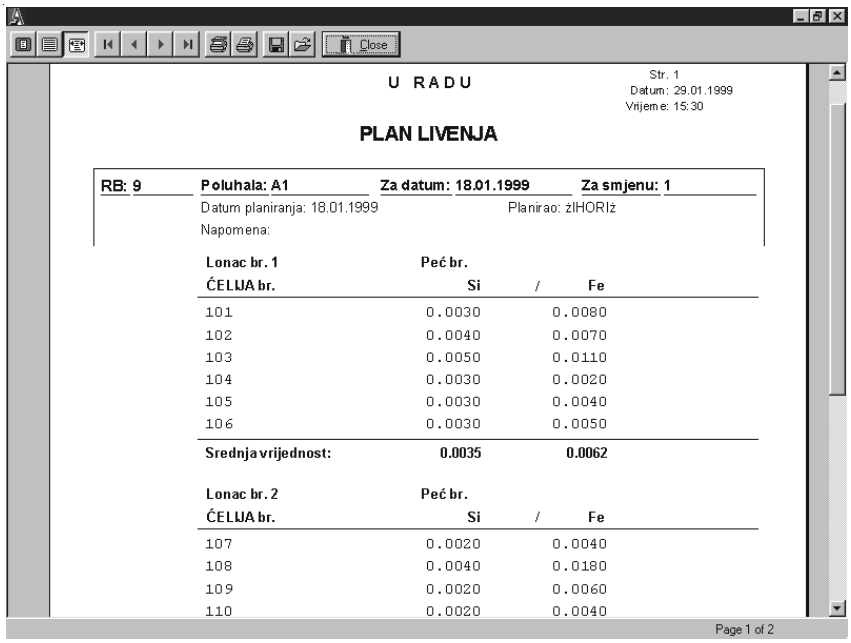

Figure 6. **Melting Schedule**
Slika 6. **Plan lijevanja**

should also provide readings on expected business results (profit, gain, productivity of single plants and stimulation for realization of production plans and sales plans as well as production effectiveness of departments and sectors.

EXAMPLES USING ISAL

The subsystem PLAEL carries out tracking and data processing in production of molten aluminum from entry of aluminous oxide raw material till delivery of molten metal in the smelter.

It contains the following modules:
- operational status of the cell,
- bath acidity measurement,
- corrections according to AlF_3 content,
- impurities content,
- delivery of molten metal from Electrolysis,
- daily work schedule of the company,
- daily production indices in electrolysis.

Figure 3. shows the monitor screen with displayed acidity data obtained by AlF_3 measurement in cells.

Figure 4. shows work schedule for four preparation and production cell stages: melting, anode, anode and the frame. After entry of these four stages for one day, we obtain automatically work schedule for the selected time (by calling the option *creation*)

PLALE subsystem can ensure planning and tracking of production operation in the smelter after obtaining of final aluminum products.

It contains the modules:
- melting plan,
- liquid metal,
- charge card,
- daily attendance.

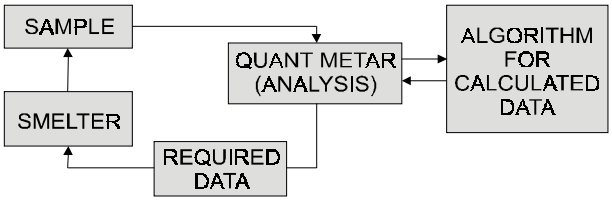

Figure 7. **Links between quant meter and ISAL**
Slika 7. **Veza kvantometra i ISAL**

Figure 5. shows procedure for work out of melting schedule, while Figure 6. gives example of such a melting schedule.

Figure 6. shows the appearance of such melting schedule obtained after choice of the workshop, date and work shift.

Figure 7. shows links between quant meter and ISAL system.

CONCLUSION

Introduction of ISAL represents highly complex task. The paper describes solutions developed during introduction and application of ISAL in "Aluminij d. d." in Mostar. International acknowledgements for the obtained level of production organization (2002) show level of achievement of such a project.

For further development of ISAL , these investigations will be performed:
- data input from processes,
- production monitoring by bar code and RF terminal,
- application of genetic algorithm for production planning,
- application of neuron networks for prediction of failures at production.

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