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LADLE MANAGEMENT SYSTEM*

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Abstract

Delivering liquid steel to a steel processing unit at right temperature is an important criterion for high production steel shops, but it is surprising how little attention has been paid in the past to manage this vital phase in the steelmaking process-the steel in transit. The ladle running costs, both directly and indirectly, contribute significantly to the cost of steelmaking and should be an area of concern to any high production steel plant. Here we are talking not only of refractory costs or preheating fuel costs, but also cost of extra heating in ladle furnace, additional process delays incurred in delivering steel at right temperature to downstream unit in case proper care is not exercised at upstream unit, and occasional costs of ladle breakout due to inability to judge the residual life of the ladle. This paper emphasizes the need of a comprehensive ladle management system, an aspect which has not been properly addressed in the operations of a steel plant, in improving the productivity of a steel melt shop. Starting with review of present status and the attempts at implementation of ladle tracking in steel melt shop automation system, it looks at components of an exhaustive Ladle Management System (LMS), and finally gives an idea of benefits that will accrue from implementation of such a system in a steel melt shop.

Keywords: Ladle tracking; Relining; Temperature tracking; Ladle.

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1. INTRODUCTION

Delivering liquid steel to a steel processing unit at right temperature is an important criterion for high production steel shops, but it is surprising how little attention has been paid in the past to manage this vital phase in the steelmaking process-the steel in transit.
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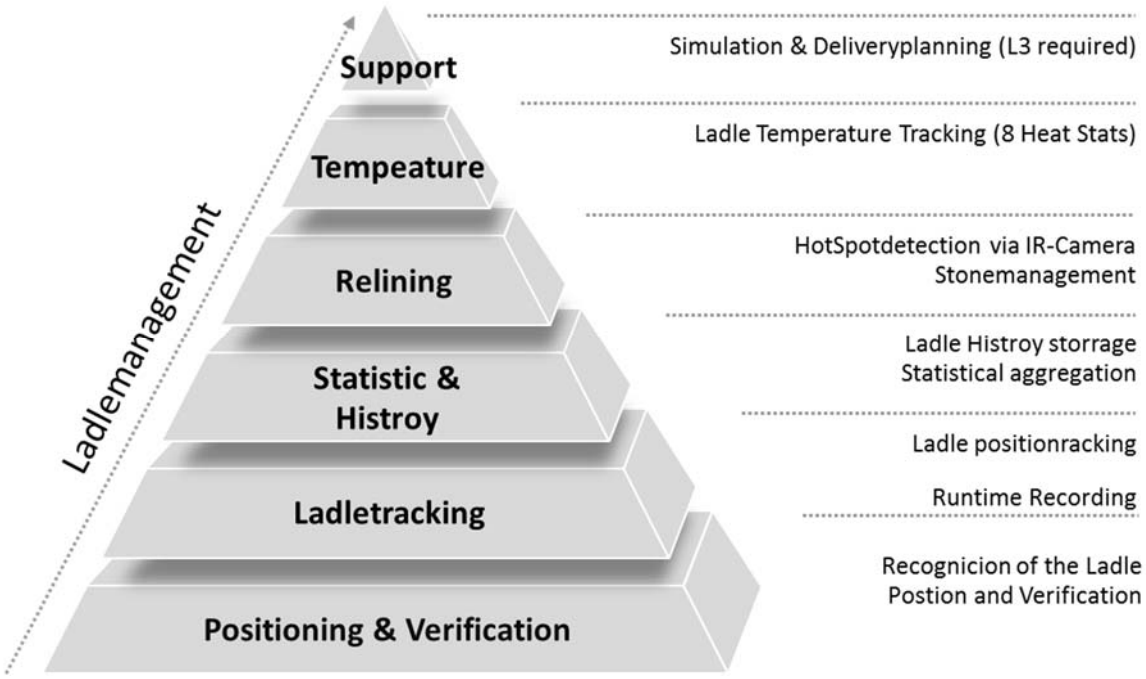
2 MATERIAL AND METHODS

2.1 Technological Highlights

The ladle management system consists of six main application modules:

- Positioning and verification
- Ladle tracking
- Statistics and history of the ladle
- Relining (Hotspot detection)
- Temperature (Temperature tracking)
- Support (requires L3)

All relevant data, process events and simulations will be rendered on a modern, sophisticated and intuitive operational graphical user interface.
For individual requirements of data acquisition several packages may be used; e.g. the identification of ladle may be carried out through our patented IR-camera system, standard camera system or SAW system, the monitoring of steel temperature by pyrometer or IR-camera and furthermore lining conditions by LACAM laser measuring system.
Which system at the end will be used depends on customer requirements and actual conditions in the plant.
The basic module of the ladle management system calculates the routes of ladles, and in case of limitations (delays, maintenance requirements etc.) alternative routes. This module determines the position of ladles, monitors the transportation times and steel temperatures (measurement). Due to that the steel plant ladle dispatcher has an effective tool to interfere in the cycling of the steel ladle in the plant; preventing bottlenecks and thus increasing productivity. The ladle handling in the plant now becomes transparent and is not anymore dependent on coincidences. The ladle traffic in the plant is predictable and the steel production is getting more stable and reliable.



Picture 1 Modular Based System design

Benefits

- **Comprehensive and consistent system for ladle management**
- **Prevention of ladle break outs**
- **Precise detection of lining conditions and thus increase of ladle ages**
- **saving of energy costs, optimisation of ladle demands**
- **Automatic detection of ladles and announcement to automation system**
- **Accurate instructions for ladle maintenance**
- **Safety check before filling of ladle (cold ladle)**

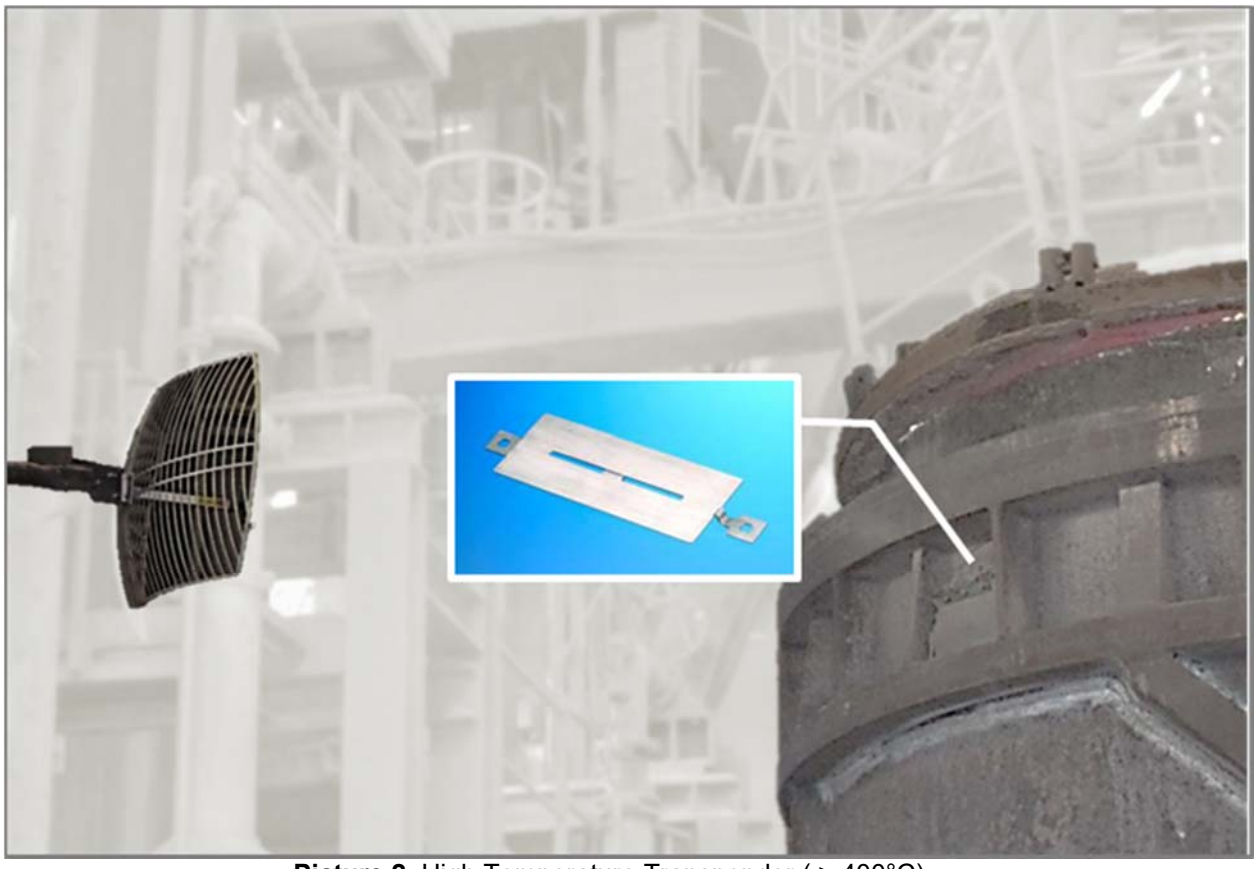
Infobox Key benefits

2.2 Ladle Management System Functions

Function modules

Module 1: Positioning & Verification

This module takes care about the movements in the steel shop. With the position data from encoders installed the system can recognize the position of the ladle transportation unit. As soon as a crane/car starts moving it gives the real-time feedback of his position. The relevant devices are steel ladle cars and cranes. Furthermore this module also identifies at certain verification points the ladle ID and forwards this information over to the ladle tracking system.



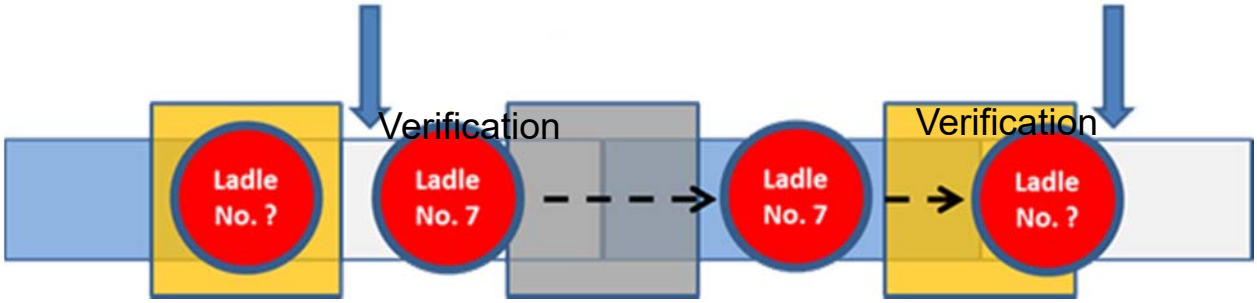
Picture 2 High Temperature Transponder (> 400°C)

Tasks:

- Position monitoring of transportation Systems
- Verification of ladle identification (ID)

Module 2: Ladle tracking

The module ladle tracking monitors the position of each ladle by use a verification sensors. The position of the ladle is recognized based on the position and verification equipment. It monitors the individual routes and stores the position and the runtime duration in the historical database. The complete information is shown in the ladle overview.



Picture 3 Ladleverification

Task:

- Tracking the Ladle position based on position & verification
- Runtime monitoring and storing life position data in the database

Module 3: Statistic & History of the Ladle

The Module stores all relevant data for the Ladle. It also stores the position of each ladle for the last two weeks. It also to append a lot more data what is coming out of Level 2/3 or other subsystems. Based on this information the system can judge the transport situation for example long waiting times between the process steps. With

this information the operator is able to further optimize the transportation situation. It also serves several Trend Information based on timing and measurement inputs.
Tasks:

- Historical Data storing
- Statistical Analyses of the stored data

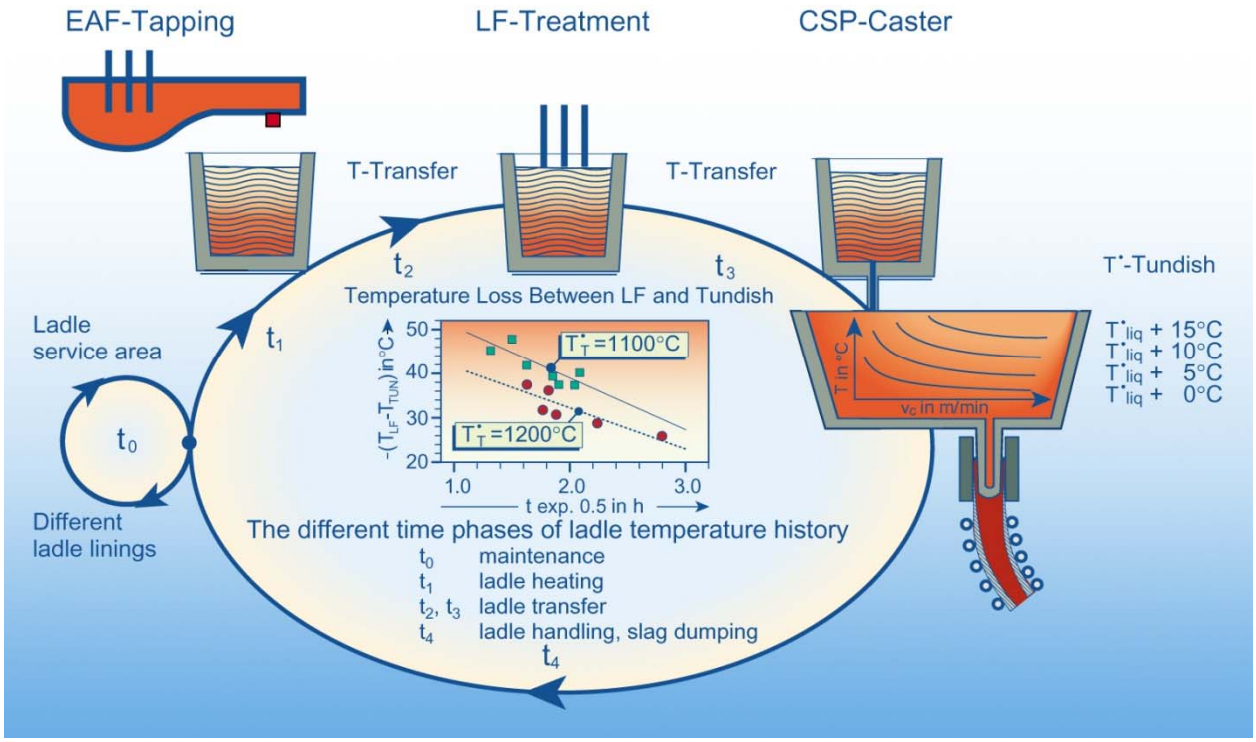
Module 4 – Relining (Hotspot Detection)

The Module gives detail information over the ladle lining status. It allows a connectivity to a four Thermal Camera (or a Lining Laser Scanner) Option. This Thermal Scanner recognizes the ladle and analyses the thermal status. Based on this information the system gives in indicator of a cold or hot ladle. It prevents the use of a cold ladle and helps to protect the works from an unexpected explosion. It recognizes hotspots as well and gives the operator a breakout warning information. This information is directly handed over to the crane operator so that he can bring the ladle in a save position in case of emergency. The status information is shown in the ladle overview.
Tasks:

- Lining monitoring (based on steel contact time)
- Hotspot monitoring (based on Thermal Camera)
- Lining Scanner (based on Laser Scanner) (OPTION)

Module 5 – Temperature (Temperature Tracking)

The Module gives a feedback over the thermal status of the ladle. The Thermal Status is calculated based on the temperature samples made during the several process steps and on the runtime from Module No. 2 and based on lining situation from Module No.4 the a thermal status (eight states - from could to hot) is calculated. Based on this information the operator can choose what ladle to be used next. The status information is shown in the ladle overview.



Picture 4 Temperature Calculation

Tasks:

- Temperature Tracking based on a simple temperature model

Module 6 – Support (requires L3)

The Support Module helps the operator to make his decisions for the ladle transportation. It collects all required data for the job handling based on a Gantt chart. So the operator can decide at what time of production a full ladle is required at the casing bay. And when is the present casting finished so he has to organize the transport true the crane driver. The individual jobs are handed over to the crane driver vie drag and drop. This action will announce a new job on crane dives job list. With a simulation system (optionally) it is possible to simulate the load situation for a complete shift and can find bottlenecks in transportation and production planning.

Task:

- Ladle Manager Decision support
- Delivery planning for main production
- Total Job handling for crane jobs out of production
- Finding bottlenecks in transportation (OPTION)

3 RESULTS AND DISCUSSION

The current installations provide a real time position of every ladle and with the aid of planning it was possible to create a prognosis of the expected temperature loss. The prediction considers the route and the ladle conditions. Based on this information it was possible to feed the present level 2 models and to optimize the required superheat.

In addition to that the Ladle Management System has helped to prepare an ideal planning of the ladle sequence for special steel grades.

Further on the system provides a clear transparency of the lining loss based on the driven production and the used lining from the different manufactures.

The management function such as lining management helped to plan the ideal amount of ladles in use and reduced the ladles under fire what helped to safe the natural gas.

4. CONCLUSION

With the aid of the LMS all activity's surrounding the ladles are going digital. Starting from the material management to the cyclic monitoring up to temperature predictions and support functionality's.

The LMS is going to reduce the amount of lining, it reduces the amount of superheat and it improves the ladles in use.

Taking the future under consideration the LMS will allow the operator automatic ladle planning in every aspect such as temperature drop. And also one of the most interesting technologies such as full automatic ladle transport requires the foundation of a Ladle Management System.

5. REFERENCES

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