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POSCO TRIZ

## Some Aspect of TRIZ Applications in Steel Making Process.

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#### **Problem Situation**

Steel plate (thickness : 40-60mm) deformed (above 5 mm) due to temperature difference between upper and bottom area of plate after ACC process.

temperature diff.	Type of deformation
in upper/bottom (Gutter)	

#### **Temperature difference Vs. Deformed rate**

Make Innovation Happen!



SCC

## **Problem description (I)**

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What we want	Current state
Temperature diff. within 25°C between upper and bottom area of plate	Temperature difference: 50°C

How to reduce temperature gradient between upper and bottom area of steel plate ??







Fact : 1) Temperature diff.(50 °C) in upper/bottom after ACC →Deformed plate

- 2) No significant temperature diff. before ACC process. (less than 30°C )
- 3) Thicker Scale formed → More temperature decline than non-scale (thinner) formed area in ACC



on roller table due to contact cooling water

2) The more delay on roller table between RM and FM, the bigger asymmetry in scale growth by cooling water

Scale thickness difference between top and bottom area of plate



#### Surface of Bottom area of Plate

Make Innovation Happen! Applying Cooling water





Not Applying Cooling water



SCC



## **Problem description (II)**

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What we want	Current state
Prevent scale formation in plate surface	Scale formed

#### How to prevent scale formation in plate surface?

#### **Restrictions of Project**

#### 1) Roll temperature must be maintained less than 100C° all the time

#### 2) The method for internal cooling of roll can not be applied due to high cost

## General way for using TRIZ typical solutions





- Contradiction
- Su-F Model
- Function

#### Model of Solution

- Separation, 40 Principles
- Standard Solutions
- Effects







#### Algorithm for Inventive Problem Solving (ARIZ)

### **Algorithm for Inventive Problem Solving**

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Example 1: Water and scale Roll move plate (main useful function) water cool roll ( useful) water corrode plate (harmful)

Initial situation/pre-problem statement:

When roll moves hot plate, plate heat the roll. Thus cooling roll by water. But water and vapor also corrode plate and make bad scale on plate surfac Scale should be removed.







#### **PART 1.1**

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1.1. Write down conditions of a mini-problem (without special terms) as follows: The technical system to move plate includes roll, plate, water, vapor, heat and scale.

TC1 : If amount of water is high, rolls are cooled enough but plate is corroded a lot by water TC2 : If amount of water is low, plate is not corrode seriously but rolls are not cooled enough

#### Under minimal changes in the system it is required: to cool roll And prevent scale formation from plate without reducing of cooling rate of roll.







1.3. Formulate Technical Contractions TC 1 and TC 2 using a conflicting pair and create their diagrams using the Diagrams of Typical Conflicts in Table 1.

A. Technical contradiction1 – TC 1: (identify)

**TC 1:** If amount of water is high, rolls are cooled enough but plate is corroded a lot by water

B. Select/create diagram of TC 1 using Table 1





**TC 2:** If amount of water is low, plate is not corrode seriously but rolls are not cooled enough

D. Select/create diagram of TC 2 using Table 1





#### Algorithm for Inventive Problem Solving

**PART 1.4** 



1.4. Select one conflict diagram from the two technical contradictions, (TC1 and TC2), that provides the best accomplishment of the main production process (the main function of the technical system specified in conditions of the problem).

The main function of the system is *to move plate, then roll cooling rate is important to operate roll system so,* TC1 should be selected: *TC 1:* If amount of water is high, rolls are cooled enough but plate is corroded a lot by water





1.5. Reinforce (intensify) a conflict, specifying a limit state (action) of elements (parts).

If amount of water is extremely high, rolls are cooled very enough but plate is corroded a lot by water



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# Algorithm for Inventive Problem Solving

#### Make Innovation Happen!

- 1.6. Write down a specified problem model:
- A. Conflicting pair : Water and plate
- B. Reinforced (intensified) formulation of a conflict
- **B.** If amount of water is extremely high, rolls are cooled very enough but plate is corroded a lot by water
- C. It is required to find x-element, which solves a conflict of the selected TC
- C. It is required to find x-element, which preserves very enough cooling rate of roll and would not create high corrosion rate of plate by extremely high amount of water



## Algorithm for Inventive Problem Solving – Part 199500

TRIZ

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1.7. Check possibility of using of the System of Standards to solve the problem model.

If amount of water is extremely high, rolls are cooled very enough but plate is corroded a lot by water

It is required to find x-element, which preserves very enough cooling rate of roll and would not create high corrosion rate of plate by extremely high amount of water





## **Problem description (III)**

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#### How to do it (AC)

How to make scale thickness uniformly in bottom area of plate during roller table

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Function Analysis Roll move plate (main function I) water cool roll (main function II) water make scale (harmful) plate hold scale (harmful)



#### IFR

Scale should be removed all by itself.

#### **Mini-problem**

It is necessary to easy remove scale from plate by introducing minimal changes in the system.



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S1, S2 : material, tool, part, person, environment
Field : M-A-Th-Ch-E-M
(Mechanical, Acoustic, Thermal, Chemical, Electrical, Magnetic)

- Desired action
- Harmful action
  - ■ ► Insufficient desired action
  - Excessive desired action







