Summary

Corus Ijmuiden is producing steel since 1924. For production of steel several ingredients are required. Sinter is one of the ingredients for the production of rough iron. It is manufactured from several fine ores. For this purpose these iron ores are mixed with each other before they can be agglomerated in the ovens.

These ores and other additive materials are discharged from bulk vessels and stacked onto their respective stockyards. These are then further transported to the sinter blending stockyard. They are stacked according to the chevron method, by means of luffing stackers. After the material is stored onto the stockyard the reclaim process takes place. The homogenisation effect is achieved as a result of the reclaim process. The reclaim process is currently carried out by a bridge type bucket wheel reclaimer.

This reclaimer is operational since 1968 and must be replaced within three years. Hence a conceptual design for the reclaimer is required. Therefore the objective of this research is to determine a concept for the replacement of a bridge type bucket wheel reclaimer according to the capacity required in 2020 (5 million ton sinter a year).

In chapter 2, there is Six Sigma Analysis carried out for prescription of boundary conditions and indication of improvement issues for the new reclaimer. According to this analysis method, first of all the process definition has been given. Further on different system parameters have been measured. Subsequently some of measured parameters have been analysed. Consecutively, the measurement and analysis of the parameters have been used to propose a set of boundary conditions. These boundary conditions are as follows: required capacity (1350 tph), mechanical properties of the bulk material, physical boundary conditions, degree of homogenisation, reduction (if not elimination) of the chute contamination, elimination of bridge contamination, reduction in waiting times, reduction in transfer time. The latter 4 are related to logistical issues.

These boundary conditions have further been used for the choice of reclaimer (in chapter 3), improvement solutions for logistical issues (in chapter 4) and the design specifications of the bucket wheel and the chute (in chapter 5).

In chapter 3, there are four bridge type reclaimers compared to each other based on a multi criteria analysis. Hereby the four reclaimer types are: Drum reclaimer, Single bucket wheel reclaimer, Twin bucket wheel reclaimer (with one trolley), Twin bucket wheel reclaimer (with two trolleys). The main criteria applied for multi criteria analysis are: Total cost of ownership, degree of homogenisation and maintenance. The result of this multi criteria analysis is used for choice of the reclaimer type. Ultimately, the choice of a twin bucket wheel reclaimer (with two trolleys) is made.

In chapter 4, different improvement solutions (for logistical issues raised in section 2) have been presented and analysed. These improvement solutions are based on the proposed boundary conditions in chapter 2. Further on, control measures have been discussed to maintain the improvements in the system.

In chapter 5, the design specifications of the bucket wheel and the chute are determined. This design is mainly based on the filling and discharge process of the bucket wheel. In addition the required power and prescribed criteria have also been taken into account during the design process too.

According to the conclusion of the study, Corus organisation is advised to choose for the twin bucket wheel reclaimer (two trolleys). This choice is not hugely based on the total cost of ownership but the degree of homogenisation has evenly been taken into account. This option is neither the best option for degree of homogenisation nor for the total cost of ownership. Hereby both the factors have evenly been taken into account. This is the reason why this option will be most beneficial for Corus.
There are some logistical issues raised during the parameter measurement (in chapter 2). According to this measurement, there are four logistical issues to be improved. These are the chute and bridge contamination, transfer time and waiting time.
For the improvement of chute contamination there are different solutions proposed. The best solution is the application of a vibratory motor behind the chute. This motor can be activated occasionally on regular basis. Due to vibration the material layer would be taken off the surface of the chute.
For prevention of bridge contamination, there have been three solutions proposed. Hereby the application of a triangular roof structure installed beside the bucket wheel is the best option. The material would land onto this roof structure instead of the bridge.
As far as the transfer time is concerned, the solutions of widening or elongation of the stockyard are proposed. In addition, construction of a wall structure along the stockyard was also one of the possibilities. The widening and elongation of the stockyard are geographically not possible. On the other hand construction of the walls along the stockyard is not a feasible solution according to the pay back period corresponding to the investment required.
Waiting times are caused either by the limited capacity of the bunkers or a failure anywhere in the rest of the transport cycle. The first reason can be tackled, while the latter is not to be avoided for the reduction of the waiting time. For reduction of waiting time and efficient use of the bunker capacity a monitoring and control system is required.
For the new reclaimer a cell less bucket wheel has been chosen with a diameter of 4.5 m. The bucket wheel has 8 buckets installed and has a rotational speed of 9.5 rpm. For further details of the bucket shape and exact dimensions, section 4.5 can be consulted.

There is a bottle neck in the transport cycle. It is the screen (kluitenzeef in Dutch) with a capacity of just 800 tph. Corus is advised to increase this capacity to a design capacity of 1350 tph.
A monitoring system for indication of the degree of homogenisation should be installed.
Corus organisation is advised to put up a study for the precise reasons (along the limited bunker capacity) behind the waiting times.
There is a study required for the relationship between the degree of homogenisation and its (financial) consequences.