Appendix 1

Process and Plant Description

Proposal No.:
Reference: RDF_Wales_DX
Dryer Type: 1 x Drum Dryer DX-1500 Proposal Date: June 8th , 2015

CONTENT

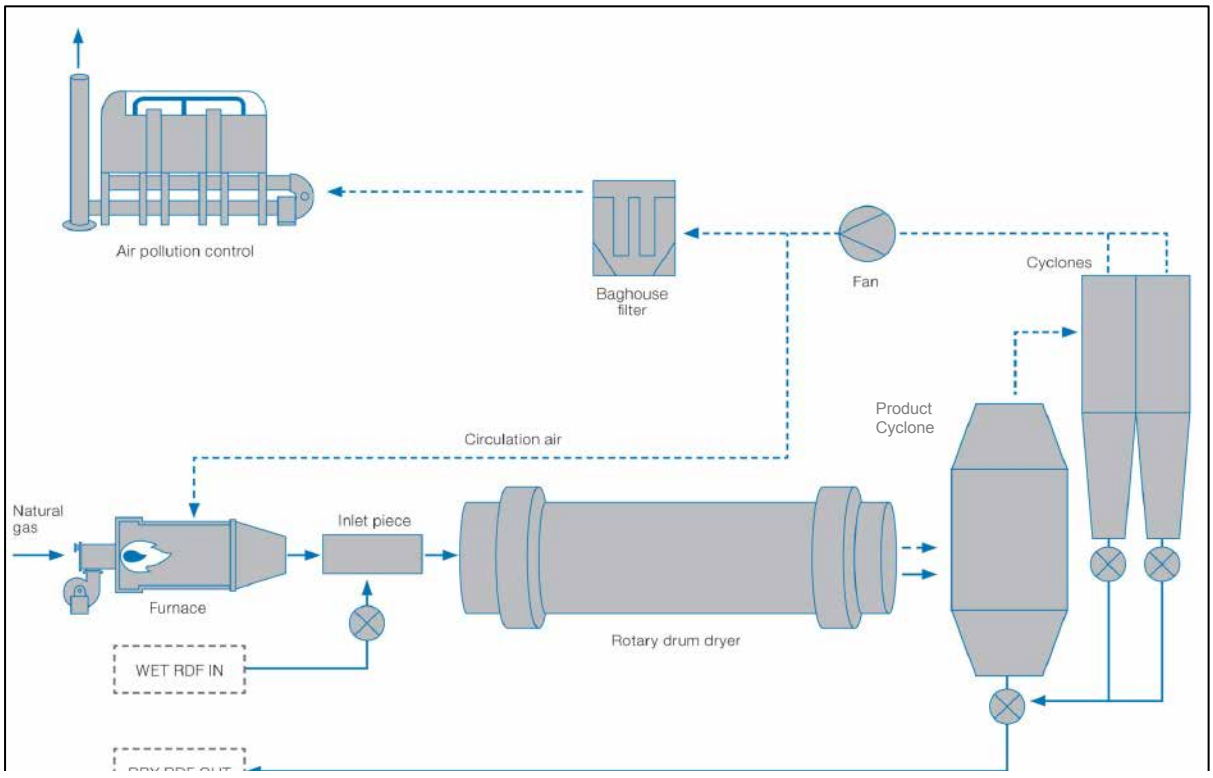
1. INTRODUCTION

This Appendix covers the topics of the proposed Refuse Derived Fuel (RDF) drying plant for the City of Wales as follows:

- Process Description
- Safety
- Maintenance

2. PROCESS AND PLANT DESCRIPTION

2.1 Overview Process Concept



2.1.1 Process Description Drum Dryer

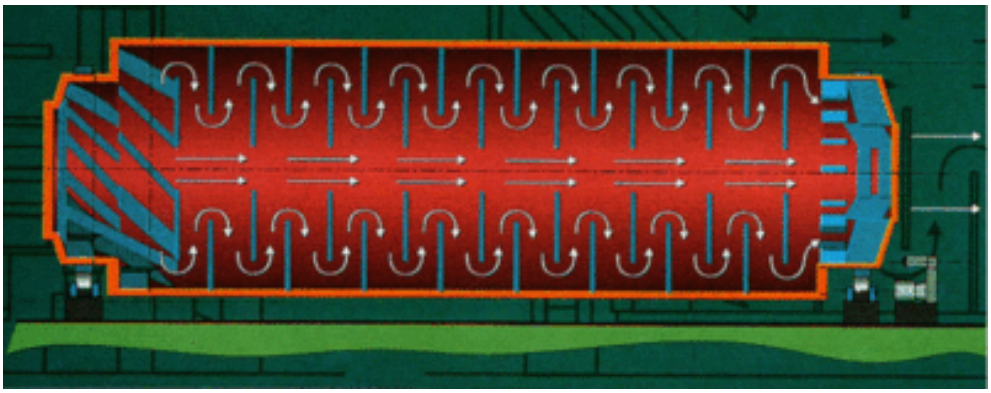
The wet product is dosed from the wet product hopper (by others) by means of a frequency controlled conveyor to the chute in the inlet piece.

The hot air for drying, so called process air, is obtained from natural gas. In the furnace the circulation air is heated by combustion of natural gas to the desired temperature for drying (about 250°C). Additionally the combustion air is preheated by available low pressure steam via a steam / combustion air heat exchanger. This process air is led through the inlet piece directly into the rotary drum.

The evaporation process of the drum drying systems takes place in a special MPS-rotary drum, the Multi-Pass System. It is characterized by:

- a turbulent rinsing of the wet product with the hot air flow
- a spiral shaped passage of air flow and wet product through the drum, which is called the Multi-Pass System

The Multi-Pass system consists of 10 drying passes in the length of the drum. The convection drying process takes place as an adiabatic cooling process. The thermal energy that is required for the evaporation of the water comes from the hot air flow. The air flow cools down considerably during the process while the product temperature itself hardly rises.



The spiral shaped passage, with 10 drying sections, the Multi-Pass Drum.

At the first contact between the process air and the wet product a spontaneous evaporation occurs, resulting in a fast temperature drop of the drying air.

Following this a slower and progressive dehydration takes place in the next sections of the drum. The off-gas temperature at the drum outlet is approx. 110°C. During the process the dry solids content of the product will slowly rise to the required level, depending on the various process parameters.

As a result of the Andritz-Vandenbroek drying principle, the temperature of the product will be approximately 80ºC during the process.

In other words; most of the supplied thermal energy is used for the evaporation of the moisture in the product, therefore the product temperature will remain low; only towards the rear of the drum (where most of the moisture is evaporated) the remaining energy will heat up the product. Product temperature will never be higher than the process air temperature.

Typical drum installation:

After the drum the dried product is separated from the process air in a product cyclone. A rotary valve underneath the product cyclone discharges the product out of the dryer system onto a transport conveyor.

After the product cyclone the process air is cleaned from dust and fines in a series of small cyclones. After the main fan the process air is split into two streams; one going back to the furnace; the other one going to the exhaust air treatment.

2.1.2 Process Description Exhaust Air Treatment (Bag filter and RTO)

Exhaust air treatment will occur in the Air Pollution Control system (APC). The APC consists of a jet pulse bag filter to reduce the dust content below 10 mg/m3 air and a RTO (Regenerative Thermal Oxidizer) to minimize the odorous components in the exhaust gas.

Baghouse Filter

The baghouse filter is designed to separate dust and fines from the exhaust air flow of the dryer air flow prior the RTO. It comprises an impulse filter with fully automatic “online” cleaning of all filter bags with compressed air. Underneath the filter a screw conveyor conveys the dust to a rotary valve. The cleaned air flow enters the Regenerative Thermal Oxidizer.

Regenerative Thermal Oxidizer (RTO)

The RTO will be specifically designed for odour control in difficult environments and with the following features:

- Full three canister design
- Negative purge
- Vented double seal canister dampers to eliminate cross leakage
- High residence time
- Ability to operate at elevated temperature if required

The oxidizer will incorporate three heat exchanger canisters, each will be filled with ceramic media. These canisters will alternately have different functions on a cyclical basis. At any given point in the operating cycle one canister will function as an inlet (preheating incoming process exhaust), one will function as an outlet

(removing heat from the clean, outgoing, oxidizer exhaust) and one will function as a purge. Cycle changes approximately every 90 seconds will allow the system to operate at the required thermal effectiveness.

These canisters will be connected at the top by a combustion chamber where oxidation will be completed at the selected temperature and where the single natural gas burner will be located.

With the correct selection of oxidation temperature and residence time and with good mixing, destruction efficiency within the combustion chamber will approach 100%. The destruction efficiency of the whole oxidizer system will, however, depend upon the effectiveness of the inlet and outlet dampers. On cycle change, if an inlet canister is immediately changed to become an outlet canister, then a volume of contaminated air equal to the volume of the canister would be emitted to atmosphere, thereby reducing the overall destruction efficiency from the odours. For this reason, the canister will be purged prior to change from inlet to outlet mode and the contaminated odourous content will be oxidized in the normal manner. The efficiency of this operation has a large effect on the overall destruction efficiency. The RTO system includes number of features specifically designed for the exhaust air process.

a) A combination of non-uniform ceramic packing media and monolithic blocs is used. This is a robust form of packing media, well proven in challenging installations.

b) The RTO will be designed so that it can operate continuously at temperatures up to 850 ^{0}C

c) The RTO will have one second retention time (at high temperature) which will give an excellent destruction of odours.

d) Offline bake out system to remove any organic particulate that may block the media beds over time.

After thermal oxidation the exhaust air will be passed to a stack.

2.2 DESCRIPTION OF THE CONTROL SYSTEM

2.2.1 Temperature Control of the Dryer

The maximum temperature of the dryer is limited by the moisture content of the wet product.
Since this is not measured in the process, it is important that the operator doesn't increase the capacity beyond the safety limit of the furnace temperature.

Moisture content entrance	Maximum furnace temperature
Mass % water	°C
20	200
25	200
30	250
35	300

Table 1: Maximum furnace temperature

The outlet temperature of the drying drum is controlled by the capacity of the burner (burner control). During start up the set point will slowly increase by a ramp until the final set point is reached.

2.2.2 Drum Speed Control

The drum runs at a fixed speed, which can be set by the operator between 50-100%. The controller will send a 4-20 mA signal to the frequency inverter of the drum motors.

2.2.3 Drum Pressure Control

The pressure at the drum inlet is controlled by sending a signal to the frequency inverter of the RTO fan (controlled by the RTO local control panel).

2.3 DESCRIPTION OF START-UP AND SHUT DOWN PROCEDURES

2.3.1 Start-up of the Drum Dryer Plant

Prior starting up the drum dryer plant all main equipment including bearings, chains etc. have to be inspected in accordance with safety regulations and lubrication schedule. The drum dryer plant will be started up from back to front. The control system will activate the start sequence after release of the start-up procedure as will be described in the Operation and Maintenance Manual.
Start-up of the drum dryer will take approx. 30 minutes; start-up of the RTO will take about 6 hours from cold or 1.5 hours from idle.

2.3.2 Shut-down

The shut-down procedure will start by reducing the speed of the RDF feed slowly. By reducing the RDF feed, the capacity of the burner will go down automatically, due to an increase of the outlet temperature as a result of the lower feed. After activating the stop procedure, shut-down sequence will take place automatically as will be described in the Operation and Maintenance Manual.
Shut-down of the drum dryer will take approx. 30 minutes, cooling down of RTO approx. 1-2 days. For shorter shut downs of the dryer the RTO will be set to idle mode.

3. SAFETY CONCEPT

Due to the nature of the material the dryer is equipped with several safety features. On the one hand measures against fires and on the other hand measures against explosions have to be taken.

3.1 FIRES

In the drying air loop and the exhaust air duct carbon monoxide and oxygen are measured. Additionally temperatures at various locations are measured. During commissioning limits for these values are established. When such a limit (high CO-value, low oxygen value or high temperatures) is exceeded a fire is suspected in the drying loop. In this case the feed to the drum, the burner and all drives in the dryer loop will be stopped immediately. Water will be sprayed automatically into the inlet piece, the drum, the product cyclone, the cyclones for separation of fines and the bag house filter.

Note: In order to avoid spreading of hot material to downstream equipment, a spark detection and extinguishing system can be installed optionally on the product conveyor. This has not been included in our price and can be reviewed during the Process hazard Analysis.

3.2 DEFLAGRATIONS

As the whole drying plant is located within a building the explosion protection concept is based on deflagration suppression.

The critical equipment in regards to deflagration is the product cyclone, the cyclones for separation of fines and the bag house filter. Each of these components is equipped with pressure sensors and suppressor canisters. The propagation of a deflagration to upstream or downstream equipment will be stopped by chemical barriers in the ductwork and by flame- and pressure proof rotary valves in the discharge cones of these components.