Causes of Bed Plugging

The TwinBed heat storage bed is subject to plugging similarly to a filter when used on furnaces with dirty flue gases. The plugging matter can be suspended particulate or vapors that condense while passing through the lower temperature zones of the regenerator bed.

There are two stages of plugging:
Stage 1: Particulate is evenly distributed in a layer on or within the bed. Combustion air flow is reduced due to the increased pressure drop, but minimal heat transfer loss occurs.

Stage 2: If plugging material is allowed to build up, combustion air may fluidize portions of the bed, causing channeling of the flow (little flow in some areas and high flow in others). In this condition, the heat recovery is reduced and exhaust temperature will rise.

Aluminum oxide (particulate) and fluxing salts (condensed vapor) are the typical contaminants in **aluminum melters**. The frequency of bed cleaning varies with each application. Two to four weeks is typical for fluxing aluminum melters and six to twelve months for non-fluxing aluminum melters. How quickly a bed will plug is affected by furnace operating procedures, production rate, quantity of salt used, quality of the charge, furnace cleaning practice, and the amount of salt allowed into the main hearth chamber.

Certain furnace operations can abnormally accelerate plugging. Alloying, furnace cleaning, and batch flux charging can release excessive volumes of particulate and vapor. If care is not taken, beds can plug within hours. Plugging can be minimized by operating the burners in "direct fire" or "stop cycle" during and for a few minutes after these operations. The dirty flue gases will then exit the flue rather than through the burner beds.

In **steel reheating** furnaces the contaminants are iron oxide particles. Cleaning usually is required after the first nine months of operation and every six months thereafter.

Glass melting has both particulate (batch carryover) and sublimed/condensed volatiles. Batch carryover sits on top, volatiles collect according to vertical temperature profile, just like aluminum furnace fluxes.

Determining Time Between Bed Cleanings

Since cleaning necessity varies significantly between furnaces, the effect of plugging on the performance of the burner should be tracked. This program of data gathering, storing, and analysis can be as simple or involved as one desires. The main idea is to develop data to compare the burner performance with a "clean" bed to that of a "dirty" bed. This information can be used to establish the time to reach an unacceptable reduction of production rate and/or furnace efficiency.

With the system operating with clean beds and normalized to all flow rates, temperatures, and pressures, the following data can be recorded for each burner: with the burner at a given firing rate (air flow), measure pressure drop across the bed; at the same firing rate, measure bed temperature and pressure drop when exhausting. The data can be recorded periodically to establish the rate of plugging and schedule a bed inspection/cleaning.

Bed Removal

Note: The amount of time to clean each regenerator varies with the material handling equipment, familiarity of the personnel with the cleaning procedure, and amount of plugging material accumulated in the bed prior to cleaning.

WARNING: Personnel must wear safety clothing including the following: face shield, dust respirator, steel toe shoes, heat Insulating gloves, heat resistant or leather clothing.

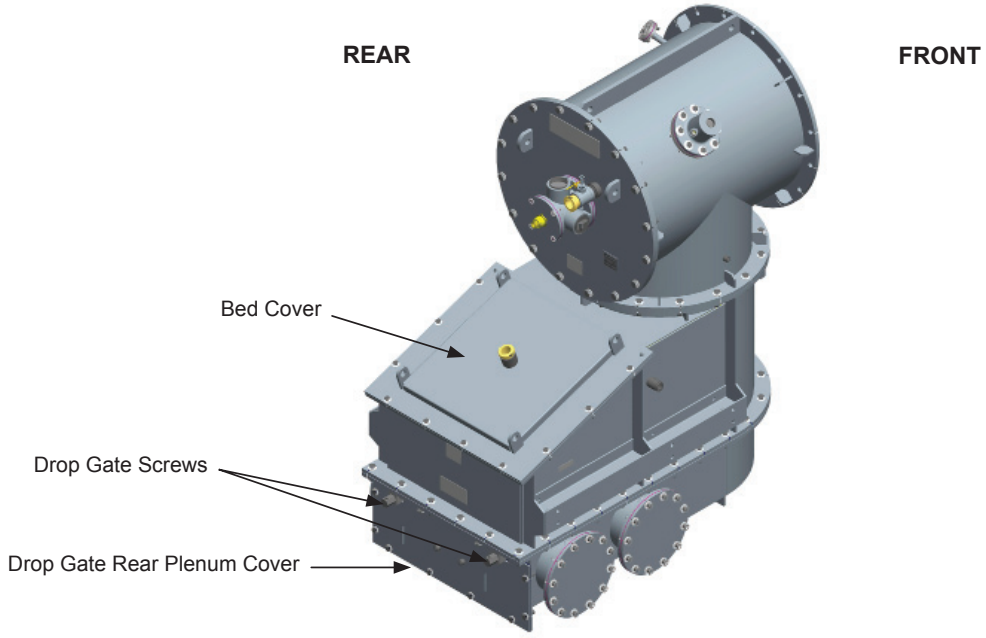
WARNING: Bed material must be cooled to safe temperature before opening burner.

Place burner(s) to be cleaned in the direct fire mode to cool the bed media. Other burner(s) can continue firing to heat the furnace while a burner is turned off to clean the regenerator. Before cooling, the temperature gradient across the heat transfer media will range from furnace temperature at top to ambient temperature at bottom. Establish a maximum working temperature that personnel can work with, then adjust the direct fire (cool down) time accordingly.

Procedure

After burner(s) have fired direct for sufficient time to properly cool the regenerator beds:

- Turn off the burner to be cleaned.
- Lock out the controls so the burner cannot be turned on.
- Close the individual burner manual gas valves to burner gas, to injector gas, and to the individual burner manual pilot gas valve for the respective burner.
- Place the furnace flue damper control into the manual mode and drive open.



Burner Bed Removal

WARNING: Maintain a negative pressure within the furnace to protect personnel cleaning the beds from contact with hot furnace gases. Under positive or neutral furnace pressures, furnace gases could exit through an open burner hatch.

Lifting lugs are positioned at each corner of the bed cover on its top surface. Each facility usually provides removal hardware suitable to their installation requirements. A suggested arrangement is the use of a spreader bar with four lifting chains and hooks for connection to four lifting lugs on the cover. The other side of the spreader bar is connected to an overhead crane or a chain hoist fastened to an overhead rail, gantry, or the forks of a lift truck.

Step 1: Connect the lifting device to the bed cover, but keep off tension.

Step 2: After removing all bed cover bolts, the cover is now ready to be removed. The cover gasket arrangement consists of a knife edge around the perimeter of the removable section and a rope gasket housed in a channel around the perimeter of the stationary bed section. It is important for the refractory construction that the lifting device be centered such that at least the first few inches of lift be true vertical.

Step 3: After the initial vertical lift, the cover may be moved horizontally away from the stationary section. It is important to keep the cover centered until it has cleared the internal sidewalls to prevent damage to the cover refractory.

Consideration of cover placement during the remainder of the bed cleaning is extremely important. Keep in mind that a knife edge male seal protrudes from the flange area and that it must be protected from damage. If the cover refractories have been sufficiently cooled, it can be set down on a wood pallet or platform. If the refractory is too hot for this, it should be placed on a heat resistant surface. Be careful not to damage the knife edge or refractory.

Step 4: With the cover removed and properly stored, move into place the container that will accept the fouled bed material.

After removing all air plenum cover bolts, the cover is now ready to be removed. The rear plenum cover has no refractory lining but large sizes are heavy.

WARNING: Keep hands away from rear of the regenerator when loosening the two drop gate screws because the support plate drops with considerable force.

Simultaneously loosen the two drop gate screws holding the rear half of the bed support plate until the plate drops into the air plenum.

WARNING: Keep clear of the rear of the regenerator. The fouled bed media will pour out immediately and could be very hot if cooling on direct fire operation is inadequate.

Step 5: A portion of the bed media will fall out as the bed support plate drops. The remainder is raked out. Most of the fouled media will be loose, however, some areas may have agglomerated and will require breaking up.

WARNING: Stay clear of the back of the regenerator. The container should be large enough to hold all the balls but some may still fall out and roll around. Before continuing with bed removal, pick up all balls on floor. Use shovel or other device as balls may still be hot.

Step 6: Rake out balls from front of regenerator.

Note: Use care during the removal process to prevent damage to the regenerator refractory.

Inspection

When all the bed media has been extracted, inspect the following:

- Remove the rear perforated support plate, check for plugging of the perforations, clean as required using a wire brush. If a wire brush does not clean the perforations, use a 5⁄16" drill to open holes.
- Clean the front stationary perforated support plate as described for the rear plate (burner sizes -10, -12A and -12B only).
- Remove (vacuum or brush) any small particles, dust, etc. that may have fallen through the perforations into the plenum chamber. Check for and remove any obstructions on the wire screens located in the air and exhaust connections.
- Inspect all refractory for damage or degradation. If required, make repairs.
- Inspect and clean seals and sealing surfaces. Replace any damaged seals.

Note: It is very important to maintain the integrity of the bed cover and air plenum cover gaskets.

Re-Assembly

Step 1: Replace the perforated bed support plate. Slide the plate onto inclined rails at the center of the plenum. Push the plate up the incline until it drops into the grooved holder. Lift bed plate and lock into position with drop gate screws.

Step 2: Carefully replace the rear air plenum cover making sure the gasket seating surfaces are clear of all dirt and debris. When the retainer is satisfactorily seated, install all bolts back into position and tighten fully.

Step 3: Fill the regenerator with clean ¾" diameter alumina balls to a level depth of 12". Be careful not to damage the burner refractories.

Step 4: Replace the bed cover by reversing the removal procedure. Make sure all gasket surfaces are clear of dirt and debris. Install and tighten all bolts.

Step 5: Open the manual gas line valves and return the furnace and furnace pressure control system to normal operation.

Media Cleaning

The heat transfer media can be cleaned by tumbling to separate the contaminants or by washing the media with a water spray.

Dry Method

The contaminated ¾" diameter balls are placed into a perforated rotating drum, or onto a stationary perforated flat plate. The rotating drum will separate the dust and small pieces automatically while the charge is manually raked when the flat plate is used.

A vibratory finishing mill such as those of SWECO Corp. will make the process automatic. These machines can be totally enclosed to contain all the dust, and can be fitted with discharge classifying screens and dust separators.

Wet Method

Similar to the dry method, but with the addition of a water spray or jet. Disposal of the spent water has to be considered for environmental reasons, since it will contain dissolved salts.

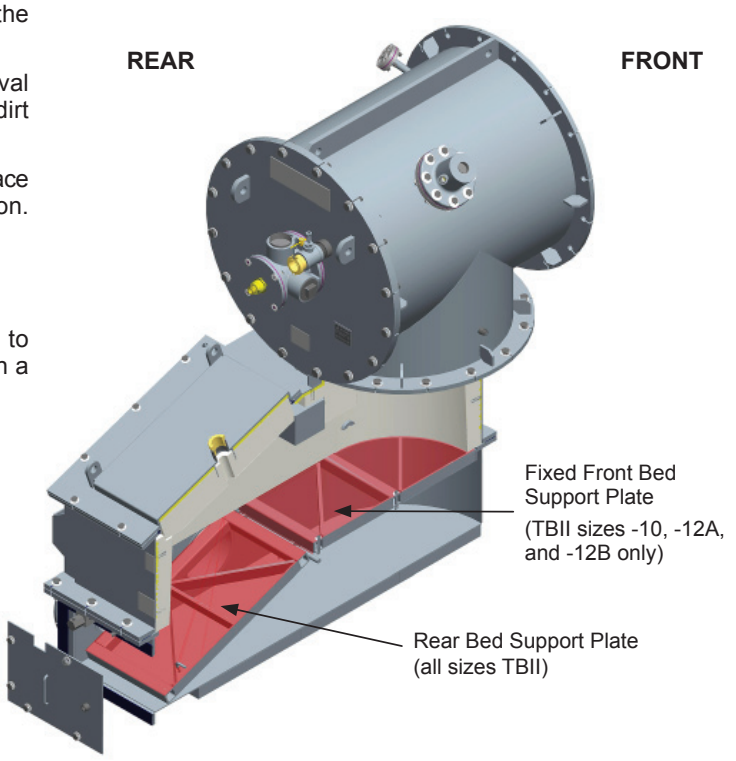
Glass – volatiles are usually Na_2SO_4 which is very soluble in water, but batch carryover is not water soluble.

Aluminum – fluxing salts are water soluble. Aluminum oxide or dross is not.

Note: A wet media charge should not be placed into the regenerators. Sufficiently air dry prior to placing in the regenerator or run burners in direct fire for sufficient time to ensure a dry charge.

Sizing Media

There will be some breakage of the balls because of splitting or shelling. These smaller pieces should not be put back into the regenerators, since they could plug the holes in the perforated support plate. They will also cause higher bed pressure drops and may contribute to accelerated plugging.



TwinBed II Data To Track History Of Regenerator Plugging
(Cycle Mode High Fire)

TB-II (_ _ A)

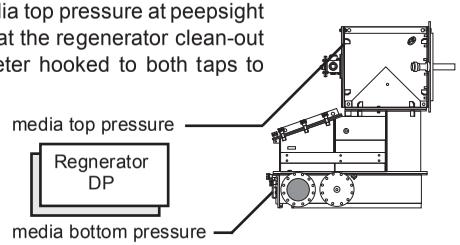
	clean regenerator						
DATE							
Furnace Temp. °F							
Comb. Air, scfh							
Plenum pressure firing, "wc							
Regenerator DP firing, "wc							
Regenerator exh. temp. °F							
Regenerator exh DP "wc							
Exhaust temperature °F							

TB-II (_ _ B)

	clean regenerator						
DATE							
Furnace Temp. °F							
Comb. Air, scfh							
Plenum pressure firing,"wc							
Regenerator DP firing, "wc							
Regenerator exh. temp °F							
Regenerator exh. DP "wc							
Exhaust temperature °F							

NOTE: Regenerator DP is measured across the media section only. It does not include resistances from valves or tiles. Measure media top pressure at peepsight on back of burner. Measure media bottom pressure at the regenerator clean-out door. Use a pressure differential gauge or manometer hooked to both taps to directly read the pressure differential.

DP = differential pressure



DETERMINING TIME BETWEEN BED CLEANINGS

Regenerator plugging should be tracked to compare burner performance of a "clean" bed to that of a "dirty" bed. The data can be recorded periodically to establish the rate of plugging and schedule a bed inspection/cleaning.

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