Pet Coke Dewatering Incorporating Innovative Vibratory Technology Coking.com Safety Seminar, May 2006

As refineries strive to increase throughput many are dealing with heavier crude feed stocks and higher carbon residue in the cokers. Delayed coking may become a production bottle neck and reduced coking cycle time is of growing interest.

To reduce the cycle time coke handling procedures require improvement to decrease time investment necessary to produce a pet coke suitable for shipment with minimal outflow of water in transit.

Dewatering of the pet coke early in the cutting process produces a material suitable for automated materials handling and minimizes storage time required to achieve the low moisture content required for shipping.

Basic Technology

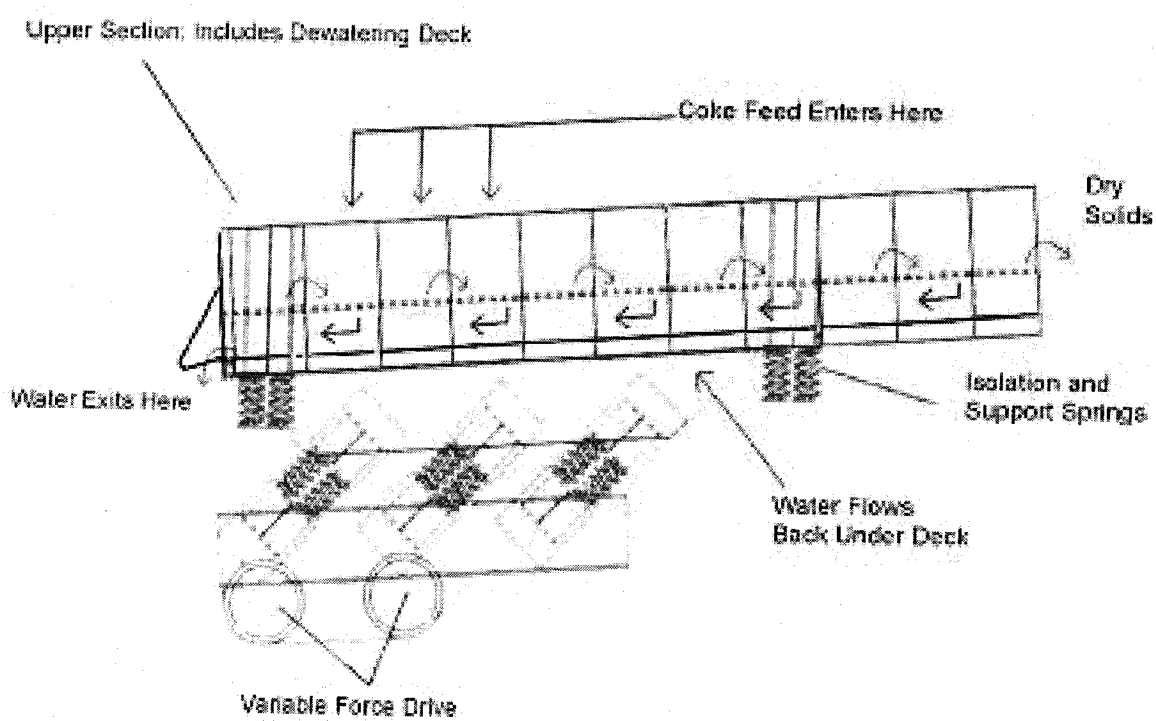


Figure 1, GKC Vibratory Dewatering Technology

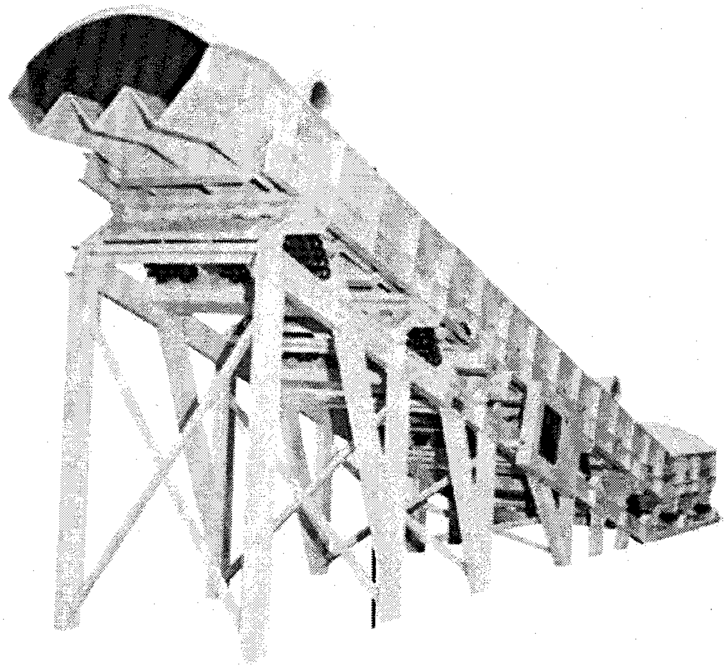


Figure 3, Inclined V-Trough Conveyor

The dewatering screen field experience provided the two mass natural frequency technology with distributed mass and elasticity for higher frequency vibratory motion for improved water percolation and the inclined V-Trough conveyor field experience provided the "improved footing" technology for substantially improved control of the wet material conveying characteristics.

General Kinematics Corporation has investigated three applicable delayed coker configurations where rapid dewatering will show substantial benefit:

1) Pit Side Clamshell Feed
2) Sluiceway Slurry Reservoir Feed
3) Under the Drum Crusher Feed

Figure 4, Pit Side Clamshell Feed

Figure 5, Clamshell Feed Configuration

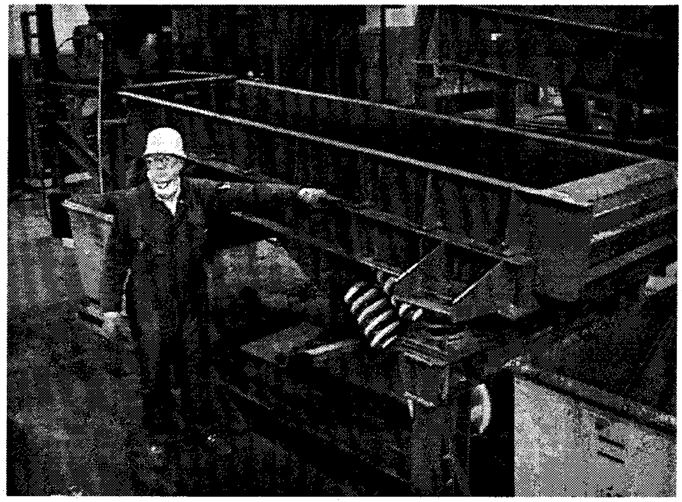


Figure 5, Clamshell Feed Simulation

This figure illustrates a small 3' wide by 12' long vibratory dewatering conveyor used to simulate clamshell feed with inundated coke. A skip hoist filled with coke was flooded with water to completely inundate the coke bed and rapidly charged into the vibratory dewatering unit. A skip hoist at the coke discharge end receives the dewatered material while the separated water under goes reverse flow due to the trough incline and discharges into another skip hoist. The dewatered coke was recycled several times to establish the relationship of length of run on the deck and residual moisture content of the coke.

The following video clips illustrate the rapid dewatering that occurs. In clip I the observer is at the water discharge end. In Clip II the observer in along the right hand side and see more of the dewatered coke discharge.

Residual Moisture Content of the dewatered coke as a function of dewatering deck length is illustrated for Uncrushed Shot Coke in figure 6, Crushed Shot Coke in figure 7, and Crushed Sponge Coke in figure 8.

Figure 6, Uncrushed Shot Coke

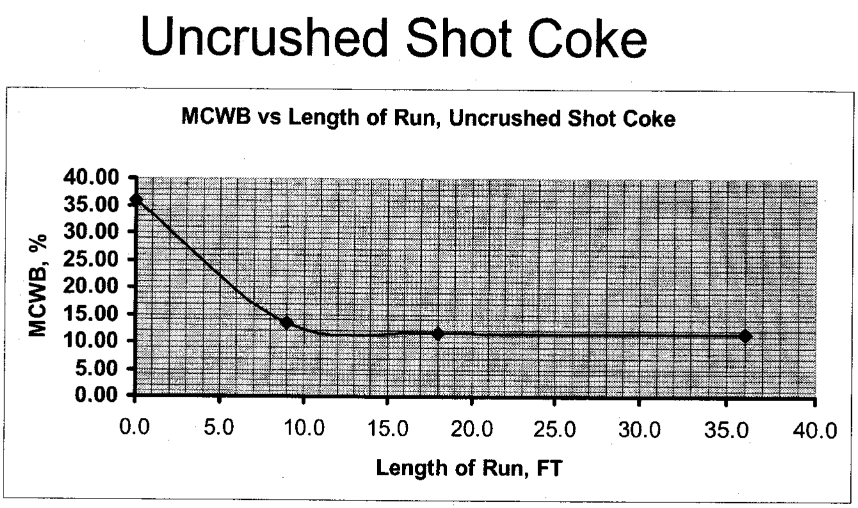


Figure 6, Uncrushed Shot Coke

Sluiceway Slurry Reservoir Feed Configuration

A schematic illustrating the Sluiceway Slurry arrangement is illustrated in figure 9.

Figure 9, Sluiceway Slurry Feed

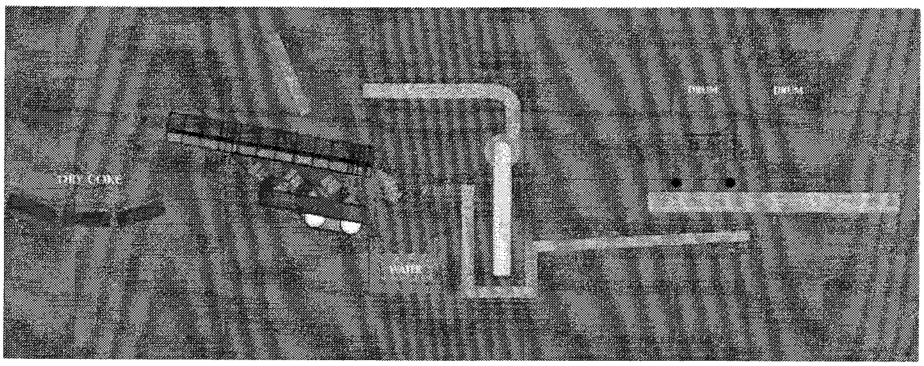
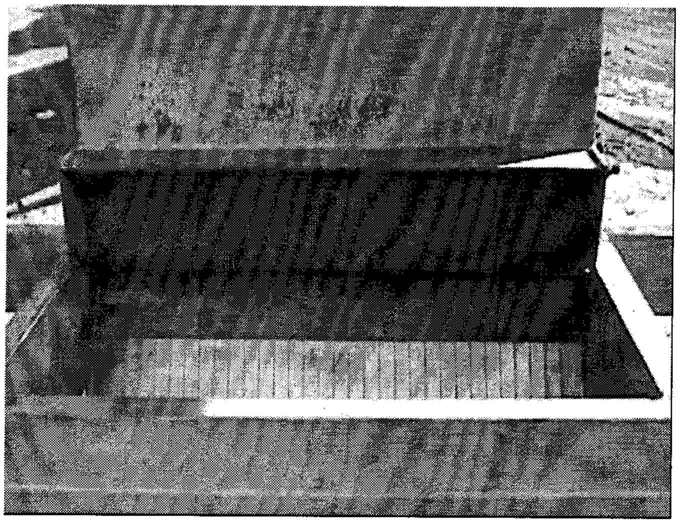


Figure 9, Sluiceway Slurry

Refineries utilizing sluiceway slurry reservoirs typically utilize mobile crusher cars to crush the coke leaving the drum prior to transfer to the sluiceway. Additional water is added to the sluiceway to facilitate coke flow to the reservoir where it is induced into a pump for transfer to some means of dewatering. Conventional vibratory dewatering screens, and rectangular or other geometrically shaped settling and drainage devices have been employed for dewatering with mixed results. High maintenance and/or insufficient dewatering are issues associated with these technologies.

The GKC sluiceway reservoir feed dewatering technology accepts the slurry from the reservoir where a "static sieve" preceded by a distribution box receives the initial slurry to initiate the free water separation process delivering a reduced moisture content flow stream to the vibratory dewatering deck. This arrangement continuously and consistently separates the excess water form the flow stream and delivers a dewatered coke stream suitable for inclined belt conveying to downstream materials handling equipment.



The vibratory dewatering conveyor used in the demonstrations was 3' wide and 12' long. During the demonstrations the coke feed rate and slurry ratio were varied. Figure 12 provides the coke and water rates, the residual coke moisture content, and the return and feed water solids content measured throughout the demonstrations.

Σ Solids Feed, TPH	H2O to Solids Ratio	Dewatered Coke MCWB, Lb/Lb	Solids in Return Water Slurry, Lb/Lb	Solids in Supply Water, Lb/Lb
25.27	2.86	0.153	0.043	.029
41.32	2.04	0.128	0.059	.046
39.85	2.10	0.135	0.043	.041
47.59	1.82	0.124	0.082	.059
48.10	1.70	0.127	0.070	.031
29.67	2.59	0.188	0.071	.064
37.31	2.06	0.139	0.065	.058

Figure 12, Slurry Reservoir Feed Results

The coke feed particle size distribution measured during the demonstration is provided in

Mesh	% Retained	% Cumulative	% Finer	dp, µM
30	12.28%	12.28%	87.7%	600
50	16.92%	29.20%	70.8%	300
100	28.13%	57.33%	42.7%	150
170	17.64%	74.97%	25.0%	90
230	6.44%	81.41%	18.6%	63
pan	18.59%	100.00%	0.0%	

Figure 15, Dewatering Deck Water Solids

Under The Drum Crusher Feed

A schematic of the Under the Drum Crusher Feed arrangement is illustrated in figure 16.

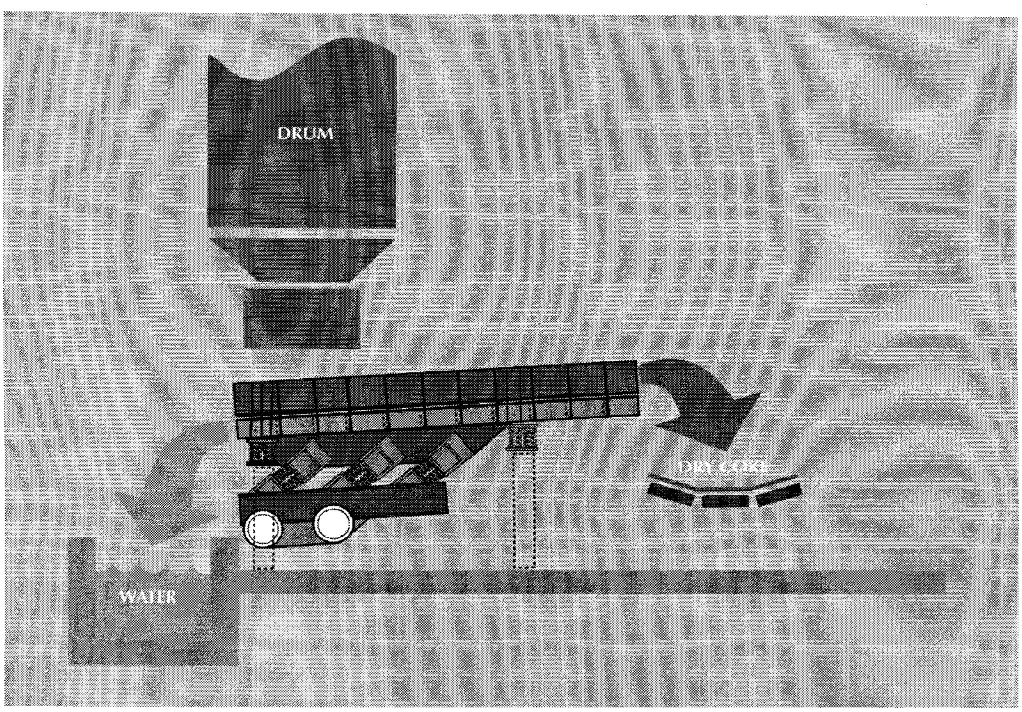


Figure 16, Under the Drum Crusher Feed

The cross section shown in figure 17 illustrates one construction used to create a wedging action where the solids flow stream moves in multiple V-Troughs with openings along the bottom to enable continuous water movement downward and out of the bed.

As illustrated in figure 18, the pressure of the slurry acts on the faces of the converging sidewalls and the reactive forces tend to form a bridging action to limit the passage of product through the water flow passages.

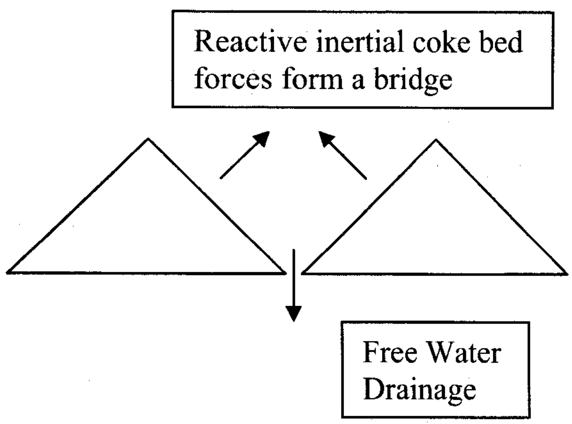


Figure 18, Material Bridge Formation

The reactive vibratory inertial forces of the bed enable the material to convey upwards along the deck while continuously discharging water.

The free water migrates through the bed towards the bottom of the "V" to discharge through the openings.

The construction enables consistent conveying of pet coke with an extremely broad range of moisture content. Free water passes the deck readily at a rate many times greater than the water from a wet pet coke flow stream. The residual moisture content of the dewatered coke conveyed over a given length of deck will vary with particle size distribution with crushed pet coke streams typically having higher moistures.

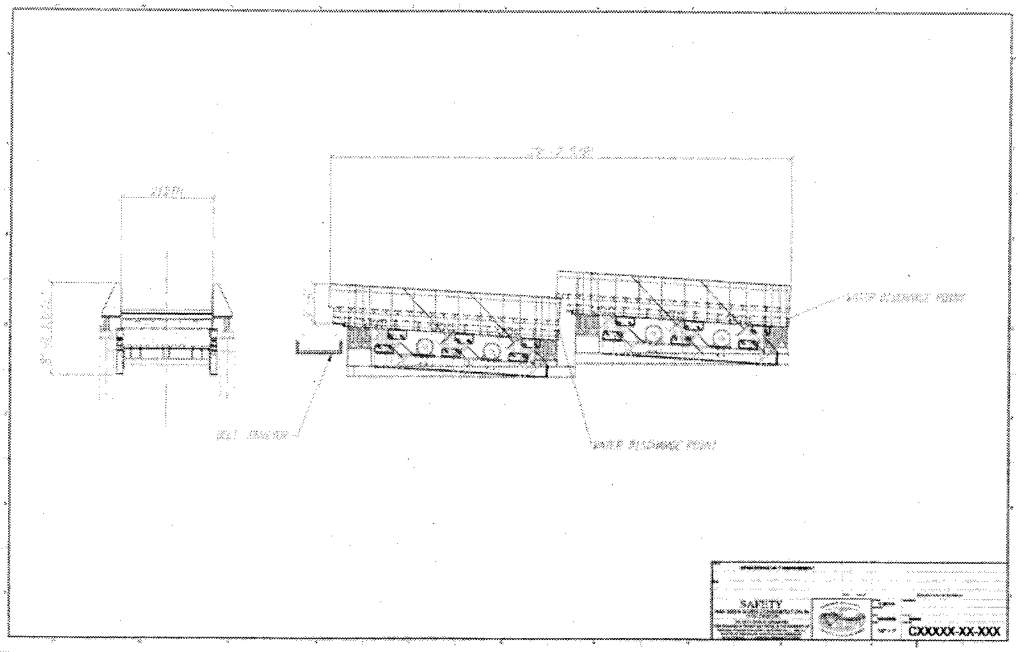


Figure 20, Arrangement of Two Vibratory Dewatering Units

Bed Depth and Percolation Rate

The rate of water percolation through the vibratory bed of pet coke is also a function of bed depth. Trials were conducted with differing depths to better understand the relationship. During the trials a vertical standpipe was clamped to a horizontally oriented dewatering deck and the assembly was vibrated vertically. Dry pet coke was added to the stand pipe while at rest to create a given bed depth. Water was added to create a constant ratio of water to dry solids, about 2:1, and vibration was initiated. The time required to pass the rush of water was measured.

Figure 20 illustrates the relationship of percolation time to bed depth. It is interesting to note that while at rest the fines in the dry solids bed created a seal when the water was poured into the top of the standpipe such that no water discharge occurs until vibration was initiated. With vibration the water passage was torrential. Note that the flow time is a liner function of vibrating bed depth.