DEVELOPING COAL TAR/PETROLEUM PITCHES

Robert H. Wombles - Koppers Industries, Inc.
Melvin D. Kiser - Marathon Ashland Petroleum Company

Abstract

Over the years the aluminum industry has evaluated the potential use of petroleum derived binders for producing anodes. Although this effort has been intense, unfortunately many of these evaluations produced less than desirable results. Initially economics drove these efforts, however in the future raw material availability and environmental regulations may drive the evaluation of all new raw materials. This paper will discuss the rationale behind developing coal tar/petroleum binder pitches including the future of coal tar pitch supplies, the potential environmental advantages of coal tar/petroleum pitches, and commercial experience with coal tar/petroleum pitches.

Introduction

The first coal chemical recovery ovens were installed in the United States in 1893. By 1915, by-product ovens accounted for 97 percent of the metallurgical coke produced in the United States. Since the building of by-product ovens, coal tar pitch has been the binder of choice for the aluminum, commercial carbon, and graphite industries.

Man has used another abundant raw material, petroleum, for centuries. The oil industry as we know it today began with the discovery of crude oil in Ontario and Western Pennsylvania in the 1850's. The complex facilities constructed to process crude oil have largely concentrated on producing transportation and heating fuels as their liquid products with little attention paid to petroleum derived binder materials. However, during the 1960’s some refineries began to show an interest in producing petroleum derived pitches. These efforts resulted in the development of petroleum pitches that had reasonably high aromaticities and specific gravities. Evaluations of these petroleum pitches as binder pitch have given mixed results with the most often cited shortcoming being higher than desirable carbon consumption.

In the late 1980’s and early 1990’s the closing of United States coke ovens accelerated due to economic and environmental pressures. These coke oven closings have left coal tar pitch suppliers and users searching for strategies to cope with the shrinking supply of coal tar. These strategies have included: 1) importing coal tar, 2) importing coal tar pitch, 3) developing processes to improve pitch yield and upgrade non-conventional coal tars, and 4) using petroleum streams to supplement the coal tar pitch supply. This paper will concentrate on the efforts to secure the future supply of binder pitch by developing an acceptable coal tar/petroleum binder pitch.

Discussion

Coal Tar and Petroleum Supplies

A discussion of coal tar supplies is the traditional “good news/bad news” scenario. The good news is that, as Figure 1 indicates, the supply of coal tar in the world is more than adequate to produce all pitch requirements well into the future.

The bad news is that the coal tar is not always located at the point of demand, especially in North America. Figure 2 projects that North American coal tar supplies will decline by 18% between 1997 and 2005 due to the factors discussed earlier.

Figure 1 – World Coal Tar Supply

Figure 2 – North American Coal Tar Supply Trends

Table I – North American Binder Pitch Demand

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Industry</td>
<td>627</td>
<td>654</td>
<td>649</td>
<td>657</td>
<td>678</td>
<td>696</td>
</tr>
<tr>
<td>Commercial Carbon</td>
<td>108</td>
<td>112</td>
<td>95</td>
<td>100</td>
<td>108</td>
<td>115</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>170</td>
<td>160</td>
<td>159</td>
<td>140</td>
<td>127</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>905</td>
<td>926</td>
<td>903</td>
<td>897</td>
<td>913</td>
<td>911</td>
</tr>
<tr>
<td>Coal Tar Required</td>
<td>1442</td>
<td>1555</td>
<td>1514</td>
<td>1517</td>
<td>1555</td>
<td>1570</td>
</tr>
<tr>
<td>Coal Tar Available</td>
<td>1302</td>
<td>1141</td>
<td>1141</td>
<td>1141</td>
<td>1027</td>
<td>1027</td>
</tr>
<tr>
<td>Tar Deficit</td>
<td>140</td>
<td>414</td>
<td>373</td>
<td>376</td>
<td>528</td>
<td>543</td>
</tr>
</tbody>
</table>

These predictions indicate the coal tar deficit will increase from 140,000 metric tons in 1997 to 543,000 metric tons in 2003. The tar deficit has the potential to be greater if the amount of idle capacity restarts or new aluminum smelter construction exceeds predictions.

As has been clearly demonstrated in the previous discussion, strategies to deal with the declining American coal tar supply need to be implemented. One of these strategies is the use of coal tar/petroleum binder pitches. Toward this end Koppers began product development in the late 1980’s to produce acceptable coal tar/petroleum binder pitches using petroleum pitches produced by Marathon Ashland Petroleum Company LLC. This strategy is particularly attractive since, as will be discussed next, there is an abundance of potential petroleum feedstocks. Also, considering the economics of other strategies, it is also the most economical.

In order to discuss comparative quantities of materials the coal tar supply is being converted to the traditional volume measure in the petroleum industry, the barrel. The total yearly supply of coal tar in North America is about 6 MM barrels. To put that number in perspective, that quantity is less than the volume of crude oil processed in the United States each day. Potential pitch feedstocks are derived from various refinery units including but not limited to thermal cracking, catalytic cracking, and specialty petrochemical units. The potential volume of pitch feedstocks from all sources is estimated to be 326,000,000 barrels per year. Assuming only 10 % of the potential feedstocks would be available for pitch production, this amounts to 32,600,000 barrels per year.

Coal Tar and Petroleum Pitch Manufacturing

Coal tar is a by-product of the coking of coal to produce metallurgical coke. Coal is heated to a temperature of approximately 1100°C in a coke oven to produce coke (the primary product) and by-products such as, coke oven gas, coal tar light oil, and coal tar. Typical yields are 70% solid products and 30% liquid products. The yield of coal tar, the feedstock for producing coal tar pitch, from a ton of coal is 30–45 liters (8–12 gallons). Coal tar pitch has many uses, but the majority of the pitch produced is used as a binder for petroleum coke to produce anodes and graphite electrodes. Figure 3 shows the flow scheme from coal coking to coal tar pitch production. As the flow scheme indicates coal pitch is produced by the distillation of coal tar.