Changes in the Asphalt Market with IMO 2020
- A Discussion -
Dr. Geoffrey M. Rowe
Northeast Asphalt User Producer Group
Portland, Maine
October 23rd, 2019
IMO 2020 – What is this?

• IMO 2020 will reduce the Sulphur levels in marine fuel
• The limits reduce to 0.5%
  • 4.50% m/m prior to 1 January 2012;
  • 3.50% m/m on and after 1 January 2012; and
  • 0.50% m/m on and after 1 January 2020.
• The change come into effect on January 1, 2020
• This will be the largest change in Sulphur levels in the maritime industry and will have a profound effect on the supply of marine fuels

IMO 2020 – Why does this effect us?

• Why does this effect me as an asphalt technologists?
  • Lots of headlines!
  • How will crude slates change that are used for asphalt/bitumen (the liquid) production?

• As a result of this I decided to have a look at what’s happening?
• A discussion!
The terms “sweet” and “sour” in crude business reflect amount of Sulphur in a crude supply.
Fuel oil cut and bitumen

• High Sulphur Fuel Oil (HSFO) traditionally sold as a bunker fuel into shipping markets

• Has provided a sales source for these products

• Alternates now needed
  • Shippers will need:
    • To buy different (low Sulphur) products
    • ... or fit scrubbers to shipping fleets to remove Sulphur

Sulfur stored at Syncrude’s tar sands processing site in northern Alberta, Canada (Photo by David Dodge, Pembina Institute) (http://ens-newswire.com/2013/04/15/waste-sulfur-yields-better-batteries-for-electric-cars/)
Refinery options

• Changing crude slate to sweet crude processing
• Converting (Fluid catalytic cracking) FCC units to residual cracking mode and other refinery optimization
• Increasing vacuum distillation unit cut-points
• Optimizing the use of non-residual refinery streams utilized to make compliant fuel
• Selling high sulfur residual material to nearby refineries as feedstock
• Alliances with shipowners to contract for HSFO supply from the refiner in return for the refiner providing the capital for vessel scrubbing facilities installation
  • Sell HSFO at a discount to shippers with scrubbers
• Producing bitumen/asphalt
  • Or selling to refineries that produce these materials
Some immediate thoughts

- Sweet vs. sour crude price differential will increase
- Potential that sour crude price will drop
- Potential that bitumen/asphalt production will increase
- Potential that bitumen/asphalt prices will reduce
- Other materials will be in market place for bitumen production that previously had alternate uses
  - Will we see a change in chemistry?
Some refinery practices

• Deasphalting units
• ROSE process
• Others?

• Why change refinery practices?
  • Enables production of lower Sulphur content fractions
PDA example

- PDA example output from Speight, 2006
  - Oil component (DAO) has reduced Sulphur content

- Will more PDA be in the asphalt/bitumen market?
Sulphur in bitumen

• Discussion on the Sulphur level dates to the 1910’s

• Richardson “The Modern Asphalt Pavements” identifies Sulphur as a “Chemical Characteristic of Interest” – 1907
  • The asphaltenes contain the greater part of the Sulphur present in asphalts
  • Noted ranges of 3.93 to 8.28% (in “pure” bitumen)

• Limit proposed on Sulphur – Chicago in 1915 .. Specified 3% Sulphur to address “apparent shortcomings in these specifications” (see AAPT 1935 paper by Nicholson)

• Some controversy about this – much discussion in AAPT in 1940
  • (Paper by Lewis and Welborn, Public Works Administration – with discussion)
What about Sulphur in asphalt/bitumen today

• Typical Sulphur levels vary from about 0.1 to 9.0 % in residues from Vacuum Tower Residuum

<table>
<thead>
<tr>
<th>Code</th>
<th>Source</th>
<th>PEN</th>
<th>SP, F</th>
<th>SP, C</th>
<th>PI</th>
<th>Sulfur</th>
<th>Code</th>
<th>Source</th>
<th>PEN</th>
<th>SP, F</th>
<th>SP, C</th>
<th>PI</th>
<th>Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA-1</td>
<td>Llyodminster</td>
<td>160</td>
<td>112</td>
<td>44.4</td>
<td>0.7</td>
<td>5.5</td>
<td>AAQ</td>
<td>WY/CAN</td>
<td>92</td>
<td>108</td>
<td>42.2</td>
<td>-2.0</td>
<td>3.6</td>
</tr>
<tr>
<td>AAA-2</td>
<td>Llyodminster</td>
<td>291</td>
<td>102</td>
<td>38.9</td>
<td>1.6</td>
<td>6</td>
<td>AAR</td>
<td>Maya/WY</td>
<td>76</td>
<td>121</td>
<td>48.9</td>
<td>-0.5</td>
<td>4.6</td>
</tr>
<tr>
<td>AAB-1</td>
<td>WY Sour</td>
<td>98</td>
<td>118</td>
<td>47.8</td>
<td>0.0</td>
<td>4.7</td>
<td>AAS-1</td>
<td>Arab Hwy</td>
<td>64</td>
<td>121</td>
<td>49.4</td>
<td>-0.8</td>
<td>5.4</td>
</tr>
<tr>
<td>AAB-2</td>
<td>WY Sour</td>
<td>166</td>
<td>115</td>
<td>46.1</td>
<td>1.5</td>
<td>5.4</td>
<td>AAS-2</td>
<td>Arab Hwy</td>
<td>96</td>
<td>112</td>
<td>44.4</td>
<td>-1.1</td>
<td>6.76</td>
</tr>
<tr>
<td>AAC-1</td>
<td>Redwater</td>
<td>133</td>
<td>109</td>
<td>42.8</td>
<td>-0.6</td>
<td>1.9</td>
<td>AAS-3</td>
<td>Arab Hwy</td>
<td>52</td>
<td>124</td>
<td>51.1</td>
<td>-0.8</td>
<td>6.21</td>
</tr>
<tr>
<td>AAC-2</td>
<td>Redwater</td>
<td>200</td>
<td>107</td>
<td>41.7</td>
<td>0.7</td>
<td>1.9</td>
<td>AAT</td>
<td>Maya/Blenc</td>
<td>63</td>
<td>120</td>
<td>48.9</td>
<td>-0.9</td>
<td>5.1</td>
</tr>
<tr>
<td>AAD-1</td>
<td>CA Coastal</td>
<td>135</td>
<td>118</td>
<td>47.8</td>
<td>1.1</td>
<td>6.9</td>
<td>AAU</td>
<td>ANS/CA</td>
<td>68</td>
<td>121</td>
<td>49.4</td>
<td>-0.6</td>
<td>4</td>
</tr>
<tr>
<td>AAD-2</td>
<td>CA Coastal</td>
<td>195</td>
<td>117</td>
<td>47.2</td>
<td>2.6</td>
<td>8.3</td>
<td>AAV</td>
<td>ANS</td>
<td>121</td>
<td>110</td>
<td>43.3</td>
<td>-0.7</td>
<td>2.4</td>
</tr>
<tr>
<td>AAE Blown</td>
<td>Llyodminster</td>
<td>73</td>
<td>125</td>
<td>51.7</td>
<td>0.2</td>
<td>5.2</td>
<td>AAW</td>
<td>Wtx/Maya</td>
<td>64</td>
<td>120</td>
<td>48.9</td>
<td>-0.9</td>
<td>4.5</td>
</tr>
<tr>
<td>AAF-1</td>
<td>W.Tx Sour</td>
<td>55</td>
<td>122</td>
<td>50.0</td>
<td>-1.0</td>
<td>3.4</td>
<td>AAX</td>
<td>Potaku/LA</td>
<td>51</td>
<td>121</td>
<td>49.4</td>
<td>-1.3</td>
<td>2.4</td>
</tr>
<tr>
<td>AAF-2</td>
<td>W.Tx Sour</td>
<td>82</td>
<td>117</td>
<td>47.2</td>
<td>-0.7</td>
<td>4.6</td>
<td>AAY</td>
<td>Maya/Arab</td>
<td>82</td>
<td>119</td>
<td>48.3</td>
<td>-0.4</td>
<td>5.4</td>
</tr>
<tr>
<td>AAG-1</td>
<td>CA Valley</td>
<td>53</td>
<td>120</td>
<td>48.9</td>
<td>-1.4</td>
<td>1.3</td>
<td>AA2</td>
<td>Wtx/Cost</td>
<td>58</td>
<td>117</td>
<td>47.2</td>
<td>-1.6</td>
<td>4.4</td>
</tr>
<tr>
<td>AAG-2</td>
<td>CA Valley</td>
<td>76</td>
<td>111</td>
<td>43.9</td>
<td>-1.9</td>
<td>2.9</td>
<td>ABA Blown</td>
<td>Wtxl/S</td>
<td>70</td>
<td>120</td>
<td>48.9</td>
<td>-0.7</td>
<td>2.3</td>
</tr>
<tr>
<td>AAH</td>
<td>Rangely</td>
<td>95</td>
<td>114</td>
<td>45.6</td>
<td>-0.8</td>
<td>2.8</td>
<td>ABC</td>
<td>Ms Valley</td>
<td>76</td>
<td>117</td>
<td>47.2</td>
<td>-0.9</td>
<td>6.4</td>
</tr>
<tr>
<td>AAJ</td>
<td>OK Mix</td>
<td>67</td>
<td>118</td>
<td>47.8</td>
<td>-1.1</td>
<td>1.9</td>
<td>ABD</td>
<td>CA Valley</td>
<td>47</td>
<td>120</td>
<td>48.9</td>
<td>-1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>AAK-1</td>
<td>Boscan</td>
<td>70</td>
<td>121</td>
<td>49.4</td>
<td>-0.5</td>
<td>6.4</td>
<td>ABF</td>
<td>Tijuana(H)</td>
<td>66</td>
<td>119</td>
<td>48.3</td>
<td>-1.0</td>
<td>3.5</td>
</tr>
<tr>
<td>AAK-2</td>
<td>Boscan</td>
<td>154</td>
<td>108</td>
<td>42.2</td>
<td>-0.3</td>
<td>6.9</td>
<td>ABG</td>
<td>Laguna</td>
<td>89</td>
<td>118</td>
<td>47.8</td>
<td>-0.3</td>
<td>4.05</td>
</tr>
<tr>
<td>AAL</td>
<td>Cold Lake</td>
<td>156</td>
<td>107</td>
<td>41.7</td>
<td>-0.4</td>
<td>5.5</td>
<td>ABH</td>
<td>Russian</td>
<td>98</td>
<td>114</td>
<td>45.6</td>
<td>-0.7</td>
<td>2.69</td>
</tr>
<tr>
<td>AAM-1</td>
<td>W. Tex Inter</td>
<td>64</td>
<td>125</td>
<td>51.7</td>
<td>-0.2</td>
<td>1.2</td>
<td>ABK</td>
<td>CA Wilm</td>
<td>56</td>
<td>119</td>
<td>48.3</td>
<td>-1.4</td>
<td>2.79</td>
</tr>
<tr>
<td>AAM-2</td>
<td>W. Tex Inter</td>
<td>102</td>
<td>116</td>
<td>46.7</td>
<td>-0.2</td>
<td>1.9</td>
<td>ABL-1</td>
<td>Boscan</td>
<td>87</td>
<td>117</td>
<td>47.2</td>
<td>-0.5</td>
<td>5.82</td>
</tr>
<tr>
<td>AAN</td>
<td>Bow River</td>
<td>90</td>
<td>110</td>
<td>43.3</td>
<td>-1.6</td>
<td>4.3</td>
<td>ABL-2</td>
<td>Boscan</td>
<td>169</td>
<td>106</td>
<td>41.1</td>
<td>-0.3</td>
<td>6.28</td>
</tr>
<tr>
<td>AAO</td>
<td>Arab Hwy</td>
<td>106</td>
<td>115</td>
<td>46.1</td>
<td>-0.3</td>
<td>5</td>
<td>ABL-3</td>
<td>Boscan</td>
<td>137</td>
<td>111</td>
<td>43.9</td>
<td>-0.1</td>
<td>5.86</td>
</tr>
<tr>
<td>AAP</td>
<td>OK Mix</td>
<td>71</td>
<td>120</td>
<td>48.9</td>
<td>-0.6</td>
<td>1.7</td>
<td>ABM-1</td>
<td>CA Valley</td>
<td>48</td>
<td>120</td>
<td>48.9</td>
<td>-1.6</td>
<td>1.28</td>
</tr>
</tbody>
</table>
SHRP binders vs. empirical data

• Higher sulfur contents are generally associated with higher asphaltenes and typically these binders tend to have more structure and a lower temperature susceptibility.

• The relationship is poor from data available but a trend is evident.
  • Better testing available today and a more complete analysis would most likely yield better trends and results.
SHRP binders vs. PG data

Note: Boxes in the figure show the SHRP core asphalt reference code and the Sulphur %
Correlation of sulfur type distributions with asphalt performance

- SHRP-A-667
  - “Oxidation of sulfides to sulfoxides would be expected to increase asphalt hardness/viscosity, and to increase the concentration of amphoteric species. It would also potentially increase susceptibility to water stripping and strength of asphalt-aggregate adhesion.
  - CA Coastal (AAD-1) and Boscan (AAK-1) asphalts are perceived to perform poorly with respect to one or more types of pavement distress. In this work, these asphalts were determined to contain significantly higher concentrations of aliphatic sulfide (oxidizable) type sulfur than the other two asphalts, which generally have good performance histories. Thus, a negative correlation of performance with oxidizable sulfur content is indicated.”
<table>
<thead>
<tr>
<th>Code</th>
<th>Source</th>
<th>SP, F</th>
<th>SP, C</th>
<th>PI</th>
<th>Sulfur</th>
<th>Code</th>
<th>Source</th>
<th>SP, F</th>
<th>SP, C</th>
<th>PI</th>
<th>Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA-1</td>
<td>Llyodminster</td>
<td>160</td>
<td>112</td>
<td>44.4</td>
<td>0.7</td>
<td>5.5</td>
<td>AAAQ</td>
<td>WY/CAN</td>
<td>92</td>
<td>108</td>
<td>42.2</td>
</tr>
<tr>
<td>AAA-2</td>
<td>Llyodminster</td>
<td>291</td>
<td>102</td>
<td>38.9</td>
<td>1.6</td>
<td>6</td>
<td>AAR</td>
<td>Maya/WY</td>
<td>76</td>
<td>120</td>
<td>48.9</td>
</tr>
<tr>
<td>AAB-1</td>
<td>WY Sour</td>
<td>98</td>
<td>118</td>
<td>47.8</td>
<td>0.0</td>
<td>4.7</td>
<td>AAS-1</td>
<td>Arab Hwy</td>
<td>64</td>
<td>121</td>
<td>49.4</td>
</tr>
<tr>
<td>AAB-2</td>
<td>WY Sour</td>
<td>166</td>
<td>115</td>
<td>46.1</td>
<td>1.5</td>
<td>5.4</td>
<td>AAS-2</td>
<td>Arab Hwy</td>
<td>96</td>
<td>112</td>
<td>44.4</td>
</tr>
<tr>
<td>AAC-1</td>
<td>Redwater</td>
<td>133</td>
<td>103</td>
<td>43.8</td>
<td>-0.6</td>
<td>1.9</td>
<td>AAS-3</td>
<td>Arab Hwy</td>
<td>52</td>
<td>124</td>
<td>51.1</td>
</tr>
<tr>
<td>AAC-2</td>
<td>Redwater</td>
<td>200</td>
<td>107</td>
<td>41.7</td>
<td>0.7</td>
<td>1.8</td>
<td>AAT</td>
<td>Maya/Blenc</td>
<td>63</td>
<td>120</td>
<td>48.9</td>
</tr>
<tr>
<td>AAD-1</td>
<td>CA Coastal</td>
<td>135</td>
<td>118</td>
<td>47.8</td>
<td>1.1</td>
<td>6.9</td>
<td>AAU</td>
<td>ANS/CA</td>
<td>68</td>
<td>121</td>
<td>49.4</td>
</tr>
<tr>
<td>AAD-2</td>
<td>CA Coastal</td>
<td>195</td>
<td>117</td>
<td>47.2</td>
<td>2.6</td>
<td>8.3</td>
<td>AAV</td>
<td>ANS</td>
<td>121</td>
<td>110</td>
<td>43.3</td>
</tr>
<tr>
<td>AAE Blown</td>
<td>Llyodminster</td>
<td>73</td>
<td>125</td>
<td>51.7</td>
<td>0.2</td>
<td>5.2</td>
<td>AAW</td>
<td>WTx/Maya</td>
<td>64</td>
<td>120</td>
<td>48.9</td>
</tr>
<tr>
<td>AAF-1</td>
<td>W.Tx Sour</td>
<td>56</td>
<td>123</td>
<td>50.0</td>
<td>-1.0</td>
<td>3.4</td>
<td>AAX</td>
<td>Potaku/LA</td>
<td>51</td>
<td>121</td>
<td>49.4</td>
</tr>
<tr>
<td>AAF-2</td>
<td>W.Tx Sour</td>
<td>82</td>
<td>117</td>
<td>47.2</td>
<td>-0.7</td>
<td>4.6</td>
<td>AAY</td>
<td>Maya/Arab</td>
<td>82</td>
<td>119</td>
<td>48.3</td>
</tr>
<tr>
<td>AAG-1</td>
<td>CA Valley</td>
<td>53</td>
<td>120</td>
<td>48.9</td>
<td>-1.4</td>
<td>1.3</td>
<td>AA2</td>
<td>Wtx/Cost</td>
<td>58</td>
<td>117</td>
<td>47.2</td>
</tr>
<tr>
<td>AAG-2</td>
<td>CA Valley</td>
<td>76</td>
<td>111</td>
<td>43.9</td>
<td>-1.9</td>
<td>2.9</td>
<td>ABA Blown</td>
<td>Wtx/S</td>
<td>70</td>
<td>120</td>
<td>48.9</td>
</tr>
<tr>
<td>AAH</td>
<td>Rangely</td>
<td>55</td>
<td>114</td>
<td>45.6</td>
<td>-0.8</td>
<td>2.8</td>
<td>ABC</td>
<td>Ms Valley</td>
<td>76</td>
<td>117</td>
<td>47.2</td>
</tr>
<tr>
<td>AJO</td>
<td>OK Mix</td>
<td>67</td>
<td>118</td>
<td>47.8</td>
<td>-1.1</td>
<td>1.9</td>
<td>ABD</td>
<td>CA Valley</td>
<td>47</td>
<td>120</td>
<td>48.9</td>
</tr>
<tr>
<td>AAK-1</td>
<td>Boscan</td>
<td>70</td>
<td>121</td>
<td>49.4</td>
<td>-0.5</td>
<td>6.4</td>
<td>ABF</td>
<td>Tiajuana(H)</td>
<td>66</td>
<td>119</td>
<td>48.3</td>
</tr>
<tr>
<td>AAK-2</td>
<td>Boscan</td>
<td>154</td>
<td>108</td>
<td>42.2</td>
<td>-0.3</td>
<td>6.9</td>
<td>ABG</td>
<td>Laguna</td>
<td>89</td>
<td>118</td>
<td>47.8</td>
</tr>
<tr>
<td>AAL</td>
<td>Cold Lake</td>
<td>156</td>
<td>107</td>
<td>41.7</td>
<td>-0.4</td>
<td>6.5</td>
<td>ABH</td>
<td>Russian</td>
<td>98</td>
<td>114</td>
<td>45.6</td>
</tr>
<tr>
<td>AAM-1</td>
<td>W. Tex Inter</td>
<td>64</td>
<td>125</td>
<td>51.7</td>
<td>-0.2</td>
<td>1.2</td>
<td>ABK</td>
<td>CA Wilm</td>
<td>56</td>
<td>119</td>
<td>48.3</td>
</tr>
<tr>
<td>AAM-2</td>
<td>W. Tex Inter</td>
<td>102</td>
<td>116</td>
<td>46.7</td>
<td>-0.2</td>
<td>1.9</td>
<td>ABL-1</td>
<td>Boscan</td>
<td>87</td>
<td>117</td>
<td>47.2</td>
</tr>
<tr>
<td>AAN</td>
<td>Bow River</td>
<td>90</td>
<td>110</td>
<td>43.3</td>
<td>-1.6</td>
<td>4.3</td>
<td>ABL-2</td>
<td>Boscan</td>
<td>169</td>
<td>106</td>
<td>41.1</td>
</tr>
<tr>
<td>AAO</td>
<td>Arab Hwy</td>
<td>106</td>
<td>115</td>
<td>46.1</td>
<td>-0.3</td>
<td>5</td>
<td>ABL-3</td>
<td>Boscan</td>
<td>137</td>
<td>111</td>
<td>43.9</td>
</tr>
<tr>
<td>AAP</td>
<td>OK Mix</td>
<td>71</td>
<td>120</td>
<td>48.9</td>
<td>-0.6</td>
<td>1.7</td>
<td>ABM-1</td>
<td>CA Valley</td>
<td>48</td>
<td>120</td>
<td>48.9</td>
</tr>
</tbody>
</table>

8/6/2019 Abatech
Other comments in SHRP reports

- The Sulphur, nitrogen, and metal content were used to evaluate crude oil sources and were considered in the asphalt (bitumen) selection process as were performance related physical properties such as temperature susceptibility, and aging. (SHRP-A-646)

- For the high sulfur asphalts, AAD and AAK, both the SEC I and amphoteric fractions account for 97% of the viscosity; whereas for AAG and AAM, the low sulfur asphalts, this falls off. (SHRP-A-686)

- AAG is a SOL type asphalt whereas AAD and AAK have significant structure! AAM is unusual in its characteristics.

- Low aging indices, determined from changes in the viscosity of the neat and aged binders, were found associated with asphalts having low asphaltene to resin ratios, relatively high nitrogen contents (>1%), and relatively low Sulphur contents (<2%). (SHRP-A-686)

- Implication is that the higher Sulphur asphalts age to a greater extent. However, as noted earlier this is based upon bitumens/asphalts that were used at the time of SHRP (late 1980s/early 1990s) and it is not clear if these would still apply if other forms of sulfur exist in the products being used in the future.

Memory Prompt
Low Sulphur
AAG - 1.3 to 2.9% CA Valley
AAM - 1.2 to 1.9% W. Tex. Inter.
High Sulphur
AAD – 6.9 to 8.3% CA Coastal
AAK – 6.4 to 6.9% Boscan
What about added Sulphur

• Sulphur in asphalt/bitumen is bound in many chemical structures
  • What about addition of Sulphur as a modifier?

• Sulphur been used for many years as asphalt/bitumen modifier
  • Warm mix additive
  • Stability, stiffness, rut resistance increases
  • Fatigue/cracking – mixed results
  • Water sensitivity – mixed results

• Large volume of published information from early 1970s onwards – **READ the reports**

• Still some concerns about safety and generation of $\text{H}_2\text{S}$ gas
A 100+ years of discussion
Possible trends

• Possible trend will be to see use of higher asphaltene contents in sour crude selection for bitumen manufacture
  • Will see more shipping of these products

• With regard to performance the use of higher sulfur contents (sour crudes) will tend to produce bitumen with more structure and different chemical compositions
  • Will we see different aging as suggested by SHRP reports?

• Bitumen/asphalt as a supply to add Sulphur to! Will this happen??

• We need to ensure that the rheology is compatible with existing materials.
  • Tie to other components (e.g. SARA) would yield good tie to parameters such as R-value, G-R, Gc*, T_{VEP} etc.

• Of key concern is the cracking and durability of mixtures containing binders with possibly different chemistries. We need to carefully evaluate the stiffness properties in the range 1e5 to 1e9 Pa since this drives the cracking, raveling and durability parameters

• It has been suggested that the heavy components in the sour crudes may not all be suitable for bitumen production
  • Maybe we see some of these entering the market
My perspective on the changes

• Pressure will reduce the price of asphalt binder relative to other materials produced
  • With shipping market developments – I would suspect this effect would be smaller than originally anticipated by some discussers in the industry!

• Some materials may be processed into other products in some markets and thus a asphalt/bitumen supply may be no longer available
  • USA region supplied from Canada – with heavy crudes will see little change in asphalt/bitumen properties
  • Larger changes in some other markets
  • Some additional heavy crudes will be imported into complex US refinaries

• Supply of asphalt binder will see more crude sources, most likely more structure in asphalt binders, but
  • Need to understand aging effects
  • PmB modification may need more careful consideration
    • Cross-linking and Sulphur scavengers!
    • Heavy products have been more difficult to modify
  • Need to be aware of change in heavy fractions – how asphaltenes behave is important
  • Need to be careful with PDA (PPA) – generally these are hard with lower UTI
Summary

• IMO2020 – to be implemented on January 1\textsuperscript{st} 2020
• Will and has produced a significant change in refinaries processes and materials available for bitumen production
• We need to understand if we will see change that will have consequences in the asphalt market
• History (documents reviewed, etc.) suggest that changes will occur in costs structures and performance!
  • Anyone got a good crystal ball??
Discussion

• Presentation put together by collecting available data – we have a room full of experts ..... 

  • What is your view?
  • Is this important?

Thank you for your attention