Polymer-Modified Asphalt Supply Outlook

2009 Illinois Bituminous Paving Conference
Champaign, IL
December 9, 2009

Henry Romagosa
Market Development Manager
ICL Performance Products LP
Acknowledgements

- Polymer Supply Information
  - De Witt & Company
  - Tom Brewer
Predominate Modifier

- **Styrene–Butadiene–Styrene (SBS)** is most widely used in US and around the world (≈ 90% of PMA market)
  - Excellent performance – case studies
  - Long history of success – since 1970’s in Europe
  - SBS produce a stable, compatible system easily used in today’s construction practices
Styrenic Polymers (Elastomers)

- Polystyrene is hard and brittle
- Commonly co-polymerized with butadiene
Why is SBS Currently in Short Supply?

- Styrene-Butadiene-Styrene (SBS) polymer capacity is not short
- Shortage of raw materials - Butadiene
- Ethylene production is the problem
Why is Ethylene Production the Problem?

- By-products of Ethylene Production
  - Styrene
  - Propylene
  - Butadiene
  - Isoprene
  - Pentadiene
  - Cyclopentadienes
  - Aromatic Resin Formers
  - Isobutylene
  - Amylenes
  - Hydrogen
  - Benzene
**Ethylene & Butadiene Market Comparison**

**Ethylene Market**
- 120 million tons per year
- Primary use – packaging materials
  - Plastic wrap
  - Trash bags
  - Milk jugs

**Butadiene Market**
- 14 million tons per year
- Primary use – tires (70%)
- Multiple other automotive and durable good uses
- SBS polymer for asphalt (6%)
How Is Ethylene Made?

- Basic ethylene production technology is called a steam cracking process
  - Process heats feed up to 1700 degrees, then injects steam that cracks the molecules
  - Cracker unit cost $2 billion
- Choice between gas feeds like ethane, propane and butane and liquid feeds like naphtha and gas oils.
- Output is a mixture of ethylene and other products
- Requires a downstream purification processes to separate products
What’s Important to Know About Ethylene Production

Steam Cracking Process

- Ethylene
- Propylene
- Benzene
- Butadiene
- Pentadiene
- Isoprene
- Cyclopentadiene
- Aromatics

Produced by both Gas and Liquid Feed

Only a by-product of cracking Liquid Feeds
Choosing Feeds to Produce Ethylene

- Each producer runs an economic model

- Feed availability and costs for the producer at their location
  - Yield of each feed – varies considerably
  - Demand for each product
  - Alternatives to buy versus make that product

- Ethylene and propylene are the prime products
  - Evaluate netback of all products
  - Liquid feeds generally produce 15:1 ethylene to butadiene
  - Economic impact of butadiene is not large
  - Based on the conditions producers set a feed slate for the “Cracker”
  - Butadiene shortage is not a primary consideration for feed slate
Liquids are always in the slate due to the facilities being built to be liquid crackers.

Crackers modified in the 80’s to be flexible.

Flexibility depends on producer, but varies from ~10% to ~50%.

Producing 3-5 million pounds a day a few pennies makes a big difference.
What’s Changed

- Structural change - natural gas producers installed facilities to separate ethane
  - Ethane higher value than natural gas
- Ethane prices didn’t increase with the crude oil run-up
- Economic incentive to run more ethane feed
Feed Slate Change in 2008

NPRA Liquid Cracking in N. America

2008 Liquid Cracking Down 23% vs. 2007/6
Ethylene General Trends

- Little to no capacity additions in Western World
- Significant ethylene capacity additions in Middle East and Asia
  - Most of the Middle East is gas cracking
  - Most of Asia is liquid or naphtha cracking
- New trend for ethylene units outside of US to be more flexible to be able to run more gas feeds
  - Historically have been naphtha crackers
- Expect more flexible cracking; hence, more variable Butadiene supply
Global Rubber Perspective

- Global rubber demand in 2008 is 21.4 million tons, or 47 billion pounds
- Tires are the major consumer of synthetic and natural rubber
- Butadiene is a major component in most synthetic rubber: SBR, PBR, SBS, etc
- Decreased tire demand will significantly improve butadiene supply
July 2008 - Butadiene (Bd) Supply

- Globally tight due to lighter cracking and higher demand
  - 2008 Bd supply estimated at 75% of 2007

- New Bd and ethylene capacity due on-stream in Asia

- Expected capacity utilization to be lower than 90% for the foreseeable future

- Regional differences
  - US crude Bd supply tight due to light cracking in first half
  - US has excess purification capacity and buys crude Bd from Europe to fill capacity
  - Europe tight on supply due to somewhat lighter cracking; thus, less crude Bd to export to US
July 2008 - What Factors Will Influence Supply?

**Positive**
- New capacity
- Bd pricing itself out of some applications
- High gas prices:
  - Less driving mean fewer replacement tires
  - Smaller vehicles/smaller new car tires
- Slowing economy; less growth

**Negative**
- Higher natural rubber prices driving consumers to synthetic rubbers based on Bd
- Lighter cracking
  - Higher naphtha prices
  - Structural change in US ethane market
- Low cost gas-based ethylene capacity coming on-stream in Middle East.
July 2008 - Tire Demand Data

- **New Tire Demand**
  - June vehicle production down 8% and falling
  - Vehicle production skewed towards smaller vehicles
  - Tire demand could be down over 12%

- **Replacement Tires**
  - Higher gas prices are reducing miles driven
  - Expect reduced tire demand over time
  - May take 3-6 months to play out.
October 2008

- Spread between gas and liquid feeds now down to $.05
- Demand is shrinking – tire demand is down
  - Asian market price drop of $0.10- $0.15 per lb
October 2008

- Tire Demand is down – Frees up Butadiene for SBS Suppliers
  - **Result** – 100% Bd available to SBS producers for now
  - SBS suppliers will be able to build up substantial inventory this winter
  - **Should be adequate SBS supply in 2009**
4Q 2008 Economic Decline – Makes Bd Supply Longer

- Economy progressively shut down during the fourth quarter
- Housing industry started years before
- Tire industry was the first 4Q casualty
- Adhesive industry followed quickly behind tires
- Followed by general chemicals/Ethylene
- The sequence helped increase Bd supply
Low Natural Rubber Prices Push Out Synthetic

SICOM Natural Rubber and NYMEX WTI (Prompt Month)
February 2009 - Outlook

- Expect demand to be lower than 2008 across all market segments
  - Ethylene is expected to be 10-20% lower than 2008
  - Tire demand expected to be 20% lower than 2008
- Butadiene supply should be adequate in 2009.
- AMAP was correct!!!
2010 Outlook

- Expect demand to remain at a reduced level across all market segments in 2010
- US economy not expected to have a robust recovery
  - Tire demand expected to remain low
  - Paving demand expected to be flat
- Butadiene supply should be adequate in 2010.
2010 Outlook

- **If BD demand unexpectedly increases dramatically** – supply may be tight (not likely)
- Gas feeds to crackers is less expensive at this time – increasingly lighter feed stock at end of 2009
  - Gas feed currently has cost advantage of 5¢ per pound of ethylene compared to liquid feeds
  - Ethylene production ration to butadiene production is 10 to 1
  - If more BD is required by marketplace, cost of BD must increase by 50¢ per pound to justify switch to liquid feed and offset added cost of 5¢ per pound of ethylene.
- **Conclusion** - Increase in BD demand will be supplied at a higher cost.
Alternatives to SBS Polymer

- SBS polymer-modified asphalts are typically cross-linked systems
  - Contractor friendly
    - Terminal blend supply
    - Do not require agitation
    - Storage stable
    - No major changes to HMA plant operation
    - No major changes to HMA laydown and compaction

- State DOT agencies have developed specifications specifically for SBS systems

- Alternative modification systems may require changes for both DOT agencies and contractors
Alternatives to SBS Polymer

- **SBR Latex** – butadiene based polymer that is not in short supply at this time
  - Not storage stable
  - Must be blended at HMA plant
  - Contractor now becomes asphalt modifier and must test and certify product

- **Non-butadiene polymers**
  - Reactive Ethylene Terpolymer (Elvaloy)
  - Ethyl Vinyl Acetate (EVA)
    - Used in warm climates
    - Blended with SBS in cold climates

- **Polyphosphoric Acid (PPA)**
  - An extender, not an alternative
  - Can be blended with SBS to reduce SBS content
Alternatives to SBS Polymer

- Ground Tire Rubber (GTR) – wet process
  - 18-22% GTR melted and swelled into asphalt
  - No cross-linking occurs
  - Not storage stable
  - Not a terminal blend process
  - AR binder cannot be PG graded in a meaningful way
  - Recipe specification
Alternatives to SBS Polymer

- **Ground Tire Rubber (GTR) – terminal blend**
  - Typically proprietary process
  - 10-12% GTR may be added at high temperature and processed with high shear milling
  - Chemical stabilizer added
  - SBS is sometimes used to stabilize the system
  - GTR contains non-rubber materials
    - Carbon black
    - Calcium carbonate
  - Meeting solubility specification may be an issue
  - Settlement of inert materials in contractors tank may occur
  - Cannot be PG graded under current DSR test procedures
Alternatives to SBS Polymer

- **Hybrid Binders**
  - Blend of SBS and GTR
  - Cross-linked system
  - Storage stable
  - Terminal blend system
  - Current research sponsored by FL DOT at University of Florida
Alternatives to SBS Polymer

- ‘NOTHING’ is not an option
  - PG Grading system is based on climate and traffic
  - Using the wrong grade will lead to poor performance
  - We have enough historical data to prove that PMA does improve pavement performance
  - Flexibility and creativity are needed to come up with answers
Questions?