Recent Developments in Sheet Steels from a Forging Perspective and Outlook

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Forging Technical Conference
September 12, 2018
Long Beach, CA
Concentrating on research at the interface between producers and users of steel.
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Background and Objectives

• Major developments in sheet steels over last decade.

• Possible opportunities for forging companies

• Objectives:
  1) Justify why forgers should be aware of sheet steel metallurgy.
  2) Describe some of the recent developments.
  3) Speculate about possible opportunities in the coming years.
A Bit of History

• Microalloyed forging steels
  • Major opportunity of forging companies
  • Low total cost manufacturing
  • Good for certain markets

• Where were microalloyed steels first developed and used in a major way?
Microalloyed Steels

• A major large scale use was in steel plate in early 1970s although patents in 1939-41.
• Produced by Japan for use in the 800 mile Alaskan pipeline.
• Pipe made by the UOE process using a large hydraulic press.

Gray MJ and Siciliano F. *High Strength Microalloyed Linepipe*. Microalloyed Steel Institute; 2009.
Implications

• Steel metallurgy continues to evolve to meet the needs of society.
• There is significant time from initial idea/patent to large scale use.
• Forging steels may develop from research done on other steel products.
Drivers of Recent Developments in Sheet Steels

- Automotive industry uses large quantities of steel.
- Vehicles need to become lighter and stronger.
  - Lighter to increase fuel economy and to reduce emissions.
  - Stronger to improve passenger safety.
- Steel Companies are developing sheet steels with high strength and higher toughness.
  - Higher strength means less steel and lighter vehicle
  - Higher strength often means less toughness
Automotive Sheet Steels

- First Generation
Automotive Sheet Steels

- Second Generation

Automotive Sheet Steels

• Third Generation (Gen3) Steels

Fundamental Requirement of Gen3 Steel
DP Steels

- DP (Dual Phase) steels are a mixture of ferrite and martensite. First generation.
- Strength from martensite
- TE from ferrite
Steels with Retained Austenite

- TRIP (Transformation Induced Plasticity) Steels
  - High end of First Generation Steels
  - When deformed (in use) austenite transforms to martensite increasing plastic behavior thus increasing toughness

Quench and Partitioned (Q&P) Steels

- Q&P steels concept developed by ASPPRC.
- Processing to increase retained austenite.
- Reported: 1500 MPa, 17% TE

• TBF (TRIP aided Bainitic Ferrite) Steels
• Interrupted Austempering process
• Prior forging enhances properties
• Reported:
  • 1000 MPa
  • 30% TE

Q&P and TBF steels
• Laboratory steels (not production).
• Research work to date has focused on sheet steels with lower C content than most forging steels.
• TE is not toughness, but a rough indication.

• Production runs of:
  • QP980  980 MPa  20% TE
  • QP1180  1180 MPa  14% TE
Forging Outlook

• These sheet steel compositions not yet ready for many forging applications.

• The idea of having retained austenite to increase strength and improve toughness is key.
Forging Outlook

• To get retained austenite need careful control of post forging heat treatment.

• Can be done in heat treat shop after forging, but there would be added expense.

• Like microalloyed forging steels, control of time and temperature directly off the press should be considered.
Challenges

- Development of appropriate steel chemistries.
- Post forging time temperature control
  - Continuous heat treatment conveyors?
  - Forgings are thicker than sheet. Heat extraction?
  - Precise timing needed.
  - Effective quenching needed.

- Many research and technical details to be resolved before actual implementation.
Conclusions

• Many new sheet steel (concepts) developed to increase strength and TE (toughness)
  • DP, TRIP, Q&P, TBF

• Not yet ready for forging applications
• These concepts (production schemes) may be coming to the forging industry.
• Will require precise time and temperature control post forging.
Thank You