Material Specifications & Recycling for the 2015 Ford F-150

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Overview

- Introduction
- Concept for the new specifications
- Recycling Implementation
Terminology

- **Tolling** ⇔ recycling one alloy into itself, without loss of purity, displacing new primary aluminum. This means maintaining separation between non-compatible scrap streams.

- **Recycling** ⇔ recycling a mixture of aluminum alloys into the secondary market as a lower purity product, for example sheet into castings.
Drivers for Tolling Aluminum

- Recycling aluminum = only 5-8% of the energy required to extract it new from bauxite
- Aluminum is expensive
- Aluminum cost is based on the commodity market \(\Leftrightarrow\) pricing is volatile
Tolling

- Good for the life cycle energy equation
- Lowers material costs
- Minimizes dependency on primary aluminum
  ↔ stabilizes raw material costs

For the F-150 enterprise:
- 87% of the total stamping scrap is tolled back to Novelis and ALCOA.
- Displaced 1/3 of the primary aluminum
Approach for F-150

- Tolling was a base assumption of the project
- Multi-disciplinary team:
  - Product Engineering
  - Materials Engineering
  - Stamping Engineering
  - Advanced Research Engineering
  - Purchasing
- 3 areas of focus:
  - Developing a set of recycling compatible specifications
  - Geographical consolidation of the consumption
  - Engineering a cost effective scrap handling system
F-150 at a Glance

- 2 assembly plants
- > 275,000,000kg/yr
- 3 aluminum sheet suppliers / 4 mills
- 7 alloys
- 11 unique supplier/alloy combinations

Cannot sort each of the 11 unique combinations of alloy & supplier!
Steel Grades vs. Aluminum Alloys

Steel sheet has evolved with the auto industry

- Commodity with a product engineering point of view
  - Focus on mechanical properties
  - Chemistry not mentioned

Aluminum sheet has evolved with the aerospace industry

- Engineered products
  - Aluminum Association controls alloy registration
  - Chemistry as the first differentiator

Steel Grades
Aluminum Alloys
As an automotive OEM, we want to define:

- **Automotive aluminum grades**, not specific alloys
- ** Compatible grades between suppliers**
  - Tolling scrap from one to another without loss of value (multi-suppliers tolling)
- **Contamination tolerant grades**
  - Tolling re-melts tolerate small, accidental mixes
  - Added value end of life recycling
2 automotive sheet alloy families
- 5xxx – Magnesium
- 6xxx – Magnesium & Silicon

4 major alloying elements
- Magnesium (Mg)
- Manganese (Mn)
- Silicon (Si)
- Copper (Cu)

4 minor alloying elements
- Zinc (Zn), Nickel (Ni), Chromium (Cr) and Titanium (Ti)
Skin Alloys

5 alloys still in use:
- 6005
- 6014
- 6016
- 6022
- 6451
Skin Alloys Major Chemistry

- Some overlaps, but no evident compatibility
- Expected, since they were developed independently as *Engineered Products*
Option 1:
Set the chemistry boundaries to encompass all of the candidate alloys
All of these alloys are available today, and they all make acceptable metal for closures ⇔ maybe chemistry is not that important

OK from a product designer point of view

Offers great flexibility for sourcing metal from many different suppliers
Skin Alloys Major Chemistry – Option 1

Example:

(A) produces 6451 - OK for Mg/Mn/Cu, but concerns for Si

(B) produces 6014 – too lean for (B) to ever accept any tolled metal in a mixed supply condition
So... alloy (x) from supplier (A) cannot be comingled with alloy (y) from supplier (B) and the resultant scrap tolled back to either supplier...
Chemistry Reality Check

- Chemistry does matter
- Similar mechanical properties and age hardening response behavior actually require similar chemistries
- In practice, the chemistry ranges for each alloy are much tighter than the AA registration

Real possibility to tighten the chemistry limits to enable alloy comingling and multi-supplier tolling
Skin Alloys Major Chemistry – Option 2

- Much tighter chemistry
- Overlaps, with evident compatibility
- The concept of aluminum grades is possible
Skin Alloys Major Chemistry – Final Touches

- Standardize the secondary alloying elements across all grades
- Extend the concept to create contamination tolerant grades
Vehicle  Program Engineering  Manufacturing

Ford Specifications for F-150

- Define 10 application based grades
  - 6HS/6HS2/6HS3 (6xxx high strength) for structural applications
  - 6EH/6DR1/6DR2 (6xxx Extra Hemming, Dent Resistant) for skins
  - 5HF/5ST (5xxx High Formability and Structure)
  - 6ST1/6ST2 (6xxx structure) for special structural applications

- Define 4 scrap streams
  - "Low Cu", "High Cu", "Low Mg", "High Mg"
Geographical Consolidation

- Consolidated all of F-150 stamping production into 2 Ford Plants and 2 Tier-1 suppliers
- DSP is an all aluminum plant
- 2 additional small specialty suppliers

Ford DSP & BSP and Sup 1 are included in the tolling loop.

They represent 96% of the total sheet buy.
- Mill #1 gets all of BSP’s 2 scrap streams
- Mill #2 gets all of Supplier-1’s 2 scrap streams
- DSP handles 4 scrap streams and balances scrap distribution to deliveries
Scrap Handling

- Selected a pneumatic conveying system with programmable switches instead of a traditional conveyor system.
- Each press line feeds directly to a series of in-line switches that direct the scrap to its destination.
- The system can be retro-fitted as an addition to a conventional scrap handling system, allowing mixed metal stamping plants.
- A dedicated fleet of specialized trailers handles both the coil deliveries and the return of the scrap between the aluminum mills and Ford, minimizing one way trips.
F-150 is supported by a new family of aluminum sheet specifications focused on recyclability

- 10 grades
- 4 scrap streams
- Tolling between multiple aluminum mills enabled by tighter chemistry definitions
Many colleagues participated in this effort. Among them:

- Peter Friedman and George Luckey (Research and Advanced Engineering)
- Jochen Schenk & Chris Mracna (Materials Engineering)
- Shawn Morgans & Mike Danyo (Product Engineering)
- George Stanczuk & Chip Conrad (Stamping Engineering Facilities and Equipment)