

## The science of materials for the novice – Fay Butler

This course will be taught in a way that the layman will be able to understand. Understanding metals from the atomic structure can be very beneficial to a craftsman in understanding how they move, why they strengthen, and how this can cause failure. Learning the language of metals can help in communicating with others in the field and getting into the books when problem solving. Problem solving requires the ability to retrace ones steps accurately, and an understanding of science is crucial. Fay has been teaching metals this way to non-metallurgists since 1989 and has been very successful. Hands on people with no college experience have found this very understandable and beneficial. He has taught over 1500 people.

Course outline 2 days total of 11 hrs.

9 to 3 (5.5 hrs) per day. Gather at 8:30 AM

### Free hand out 11 pages:

- 1) Definitions of terms
- 2) Periodic Chart
- 3) Tungsten Electrode current ranges/ properties of specific metals
- 4) Iron – Carbon equilibrium diagram up to 5% carbon
- 5) Iron – Carbon Equilibrium diagram up to 2% carbon
- 6) Basic AISI-SAE number system w/ percent of alloy elements
- 7) Tool Steel numbering system w/percent of alloy elements
- 8) Technical bulletin for AISI S-7 tool steel
- 9) 2<sup>nd</sup> page of technical bulletin for AISI S-7 tool steel
- 10) Aluminum Association numbering system
- 11) Picture of brass door handle with grains showing

### Included Book Package:

- 1) Metallurgy by Moniz 4<sup>th</sup> edition
- 2) Miller Power Course
- 3) Dozen page hand out included with course

### Optional Book Package: Available from Fay at Seminar

- 1) Welding Metallurgy by George Linnert, AWS publication, member \$111, non member \$148
- 2) Brazing Handbook AWS publication, 5<sup>th</sup> edition member \$102, Non Member \$136
- 3) Welding Aluminum, Theory and Practice, Aluminum Association, fourth edition \$125.00

4) User's Guide to Filler Metals, AWS publication, members \$52, Non members \$68

**Food:** Pastries, Coffee, & Lunch provided by Assabet Vocational School,

## **Course Outline:**

**Fay Butler Seminar - Structure of metals, welding and the electric current: a comprehensive 2-day course for the hands-on craftsman, novice and professional alike. No previous knowledge or experience necessary.**

Day 1 9:00 am to 3:00 pm (5.5 hrs with .5 hr out for lunch)

1. How we think. A discussion on critical thinking, the Socratic approach and what problem solving is.
2. Metallurgy, how they move, strengthen and fail, language of metals from the "inside" (atomic theory)
  - Periodic chart – metals/gas/metalloids – valance rings – inert gases?
  - Molecules vs. lattice patterns FCC BCC CPH
  - Gas/liquid/solid – lattice dendritic growth – crystals/grain
  - Size of crystal/grain correlated to strength
  - Slip planes movement – twinning in CPH
  - Lattice defects – point – vacancies and– line- planes of atoms
  - Dislocation and stacking faults (edge and screw)
  - Strengthening mechanisms – tensile strength – temper designation
  - Appropriate welding rod – how alloys work for added strength
  - Interstitial and substitutional atoms
  - Tensile strength, Hardness, and Ductility
  - Strain hardening, work hardening, age hardening, creep, use up slip planes
  - Recrystallization – anneal, recovery, stress relief, normalizing – pure metal annealing temperatures - Aluminum 600 degree f /Copper – 400 degree f /Iron 850 degree f.
3. The way metals are smelted, numbered, produced/heat treated/strengthened

- Structure of steel – basic carbon range 0.08% – .8% carbon, ferrite/pearlite Low/medium/high carbon steels
- When to use what steel – micrograph view
- Iron/carbon phase diagram
- Numbering systems AISI, SAE, ASTM
- Tool steel/cast iron – letter/number designation
- Cast iron 2%+ carbon – how steel is made
- Killed, semi-killed, capped, rimmed
- How to purchase: hot roll, P&O, cold roll
- Relationship temperature to color
- Heat-treating

4. Demonstration of making a motorcycle fender by hand using a claw hammer and an oxy-acetylene torch. Turning a flange and installing a wire edge.

Day 2: 9:00 am to 3:00 pm (5.5 hrs with .5 hr out for lunch)

1. Advanced Metallurgy  
Review of physical metallurgy and related terms. Discussion on how it relates to everyday fabrication and welding for the novice and professional alike. 1hr.
2. Principles of Welding:
  - Eliminate surface oxides and contaminants
  - Controlling the chemistry of the puddle
  - Plan for shrinkage
  - Get the proper heat in the proper area
3. Understanding the Electric Current
  - AC
  - DC EP and EN
  - Unbalancing the AC wave
  - Frequency adjustment
  - Independent amplitude adjustments
  - Starting circuits, high frequency
  - Tungsten performance and selection
  - Shielding gas, selection and purity
  - Understanding modern inverter power sources - how to adjust
4. Some hands on welding. Demonstration of making the same motorcycle fender with power equipment and using the TIG process. Turning a flange and installing a wire edge.