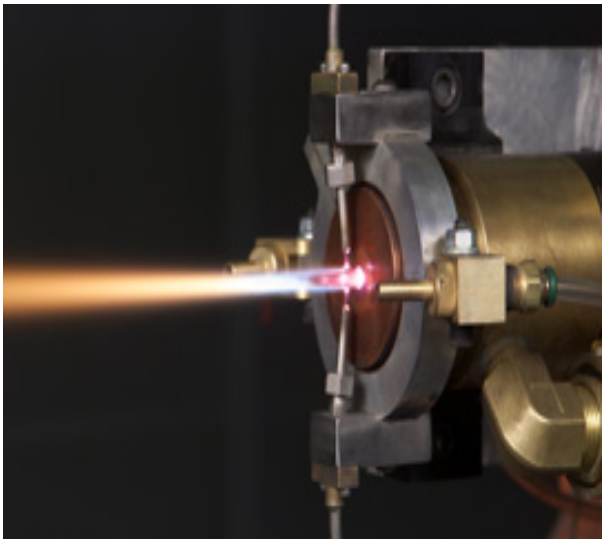

Thermal Spray Process Training

Sauer Engineering
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Thermal Spray Process Course

- Course offerings would be a combination of days and topics below
  - Theory as shown below
  - Problem solving and auditing per part or system
  - Practical hands-on
    - Pick 3-5 coatings
    - For each coating, have
      - Two–three (2-3) bad parameter sets and one (I) ideal set
      - Presentation of theory would show photos from each parameter set and how we go from bad to good
      - Try and pick coatings which show principles of bad stand-off distance, cracking, too many unmelts, etc so theory and actual spraying flow together
      - Could even take it as far as having some simple configurations machined and ask to mask/spray difficult areas
    - Also spray different powder cuts that show how powders can make a difference
      - Also different powder morphologies
  - Testing of Coatings
    - Simple presentation of 1 day up to full week of IMR Metallographic and Evaluation training (Lansing NY)
  - *Full on site demonstration of Accuraspray plume sensor*
    - Unit brought on site
    - During hands-on, will measure spray plume and provide data

- 1 week process course
  - 2 day theory
  - 1.5 day practical
  - .5-1.0 day problem solving/audit
  - .5-1.0 day testing

- Instructors
  - John P. Sauer P.E. *Sauer Engineering*
    - 15 years of aerospace experience in both Thermal Spray and training
    - Traveled around the world for training courses addressing all the requirements for major OEM's like GE, Pratt, Rolls, and others
  - Marcel VanWonderen *KLM*
    - 20 years of aerospace experience in Thermal Spray, Special Processes, and training
    - Traveled around the world for training courses addressing all the requirements for major OEM's like GE, Pratt, Rolls, and others
    - Leader in shop safety and environmental solutions
  - Varied hand-on instructors with over 25 years experience in spraying of aerospace parts in cleaning, grit blasting, masking, spray set-up, etc.

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The following subjects will be dealt with during the course. Acceptable knowledge will result in a certification of the attendant.

<u>There are 3 levels of knowledge necessity:</u>

Background information (BI) - the applicable knowledge is informative
Basic knowledge (GK) - the knowledge is important on main lines
Extensive knowledge (EK) - the knowledge is essential for the process

1. <u>General</u> (EK)

- General explanation Thermal Spraying
- Which materials can be sprayed.
- In which form can materials be sprayed
- Why is thermal spraying being used.

2. <u>Principle</u> (EK)

- Explanation of the principle of thermal spraying:
  - energy
  - heating particles
  - deposition
  - build up of a layer

3. <u>Spray processes</u> (GK)

- Explanation of the different processes in conjunction with:
  - heat generation
  - heat transfer
  - acceleration of particles
  - process-scheme

- Explanation of different processes in conjunction with
  - equipment
  - guns
  - characteristics (temperatures, velocities, bond strengths, etc.)
  - consumables (gases, fuels, pressure air, anodes, nozzles, etc..)
  - economy
  - spray materials

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4 Practical theory of thermal spraying

4.1 Pre-treatments **(EK)**

- Sequence of processes
- Cleanliness of surfaces
- other necessary processes before spraying (NDT, shot peening, etc..)

4.2 Pre-machining **(EK)**

- Geometric limits of a surface to be sprayed
- Why and when machining before spraying

4.3 Cleaning **(EK)**

- Why cleaning
- How cleaning
- What must be cleaned
- With which products one can be cleaning
- Safety and Quality

4.4 Masking **(EK)**

- Why masking
- How masking
- What must be masked
- With which products one can mask
- Quality of masking

4.5 Grit blasting **(EK)**

- Why gritblasting
- How to grit blast
- Grit blast consumables
- Quality of grit blasting

4.5 Coating thickness calculations **(EK)**

- Quantity of spray materials
- Final spray dimension
- Thickness calculation
- Use of test strips
- Example of calculations

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4.7 Pre-heating **(EK)**

- Why pre-heating
- How pre-heating
- Which methods to pre-heat.

4.8 Spraying **(EK)**

- Choice of:
  - the spraying material
  - the spray process
- economical aspects
- coating properties
- availability of equipment

4.8.1 Spray materials **(GK)**

- Wires (solid and cord=wire)
  - Pure metals
  - Alloys
  - Ceramics
  - Pseudo-alloys
  - Applied materials and their properties

- Powders
  - Characteristics:
    - chemical composition
    - powder size
    - powder size distribution
    - particle shape
  - Type:
    - Metals
    - Alloys
    - Non-Metals
    - Ceramics
    - Carbides
    - Mixtures
  - Production
  - Treatments
  - Applied materials and their properties

- Bond mechanism
  - Explanation
  - Energy transfer (3 phases)

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- Velocities
- Temperatures
- Dwell time
- Absorption time
- Feeding time
- Ideal process requirements
- Powder particle properties:
  - size
  - specific mass
  - heat conductivity
  - heat enthalpy
  - melting point
- Influence of spray parameters
  - spray distance
  - powder injection

4.8.2 Choice of the spray process **(GK)**

- Technical reasons (corrosion, wear, high temp)
  - Different kind of wears
    - abrasive
    - adhesive
    - fatigue
    - erosive
  - Choice of the material
  - Choice of the form of material

- Economical reasons
  - Costs of:
    - spray equipment (incl. spare parts)
    - consumables (e.g. gasses)
    - labor
    - environment and health/safety

4.8.3 Technique of spraying **(EK)**

- Adjustment of parameters
  - spray angles
  - spray distance
- Temperatures
  - cooling
  - cooling breaks
- Bond coats
- Circumferential speeds
- RPM's

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- Gun speeds
- General tips on:
  - Spray powders
  - Powder feed equipment
    - calibration
  - Condition of nozzles and electrodes
  - Spraying of samples
  - Roughness of sprayed coating
  - Copper and copper alloys
  - Porous surfaces

4.9 After treatment **(GK)**

- How, what and why fusion ?
- How, what and why impregnation ?

4.10 Inspection **(GK)**

- How, what and why inspection ?

4.11 Reinigen **(GK)**

- How, what and why cleaning after spraying ?

4.12 Post machining **(GK)**

- How, what and why post machining
  - sound (vibrations)
  - cutting tools or grinding wheels,
  - smoke
- Turning
  - choice of cutting tools or bits
  - side relief angle
  - radius
  - cutting speed and depths

- Grinding
  - guidelines (cooling fluids, grinding pressure, dressing, balancing)
  - grain sizes
  - hard/soft stones
  - binding materials
- Superfinishing, lapping, polishing

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5 **Quality management (GK)**

- Reproducability
- Quality care of thermal spray equipment,
- Quality care of parameters,
- Quality check:
  - Spray material control
    - test reports
    - procedures for new materials
  - Quality control of coatings
    - the brush test
    - the bend test
    - the dimple test
    - the tensile bond strength test
    - the macro-hardness test
    - the micro-hardness test
    - the scratch hardness test
    - microscopical investigation
    - appearance of the coating
  - practical testing

6 **Health and safety (EK)**

- Noise
- Dust, smoke and vapors
- UV-radiation.
- Breathing protection
- Skin protection
- Eye protection
- Ear protection
- Occupational laws
- Gasses
  - Hydrogen
  - Acetylene
  - Oxygen

6 **Organization of a spray shop (BI)**

- Gas supply
- Electricity
- Pressurized air
- Dust collection and exhaust system
- Grit blast equipment
- Cooling equipment
- Manipulation equipment
- Computer controlled equipment / robotizing
- Storage of spray materials and grit blast materials
- Post machining equipment

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