MATERIALS NEWS

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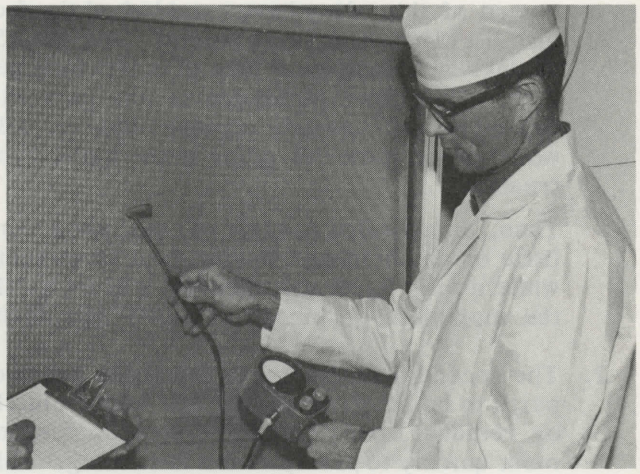
HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

Tektronix has approximately 450 HEPA filters installed throughout the Tek Park and Sunset Plants. Their use for filtering particulate matter varies from air compressors to clean room facilities.

HEPA filters have been used on air compressors at Tek for about 12 years, but more recently the emphasis has been on clean work stations -- rooms, benches, suspended modules, etc.

During the past 10 years Maintenance Engineers and Technicians have learned much about these filters. The following are some indicators of the kinds of things with which we have been concerned.

1. Compared with the best quality air filter in general use throughout the Tek air conditioning system, HEPA filters average $15.00 higher per square foot. Therefore, they are generally used only when "highly clean" air is needed.
2. HEPAs are designed to filter 99.97 percent of all particulate matter .3 micron or larger. But improperly sealed filters will negate this capability by permitting particles to bypass the media and contaminate the working environment.
3. To date, the best test of filter media efficiency and proper installation is by the use of the Dioctyl Phthalate (DOP) smoke test which we conduct here as shown in the accompanying photograph. The upstream air is charged with Dioctyl Phthalate and a photometer, designed for such testing, is used to monitor the particles downstream of the filter.
4. Over 80 percent of all filters thus tested have required repairs; 95 percent of all mountings permitted air to by-pass the filters.
5. A few leaks were caused by punctures after installation, but by far the largest percentage were about equally divided into three other categories:
   a) factory defects
   b) handling
   c) improper installation.
6. Although we understand that the various suppliers obtain their filter media from one manufacturer, we have found variations in both media thickness and uniformity. The different brands also vary in the number of leaks that can be expected, and types of sealants, gasketing and frame construction used.



Checking air flow after installation of filter.

In brief, highly important factors are (l) obtaining a filter produced according to high quality standards and (2) installation by trained personnel.

If anyone is in need of information on specific filter manufacturers or assistance in any other way, he may call Bob Herren at Ext 456.

-Bill Ethridge, Ext 7085
Maintenance Eng.

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DIMENSIONAL CHANGES DURING HEAT TREATMENT OF AGE-HARDENABLE ALLOYS

Like many high-strength metallic materials which derive their high strength properties from thermal treatments, age-hardenable alloys, for example the Cu-Be alloy designated as "Berylco 25" or the Ni-Be alloy commerically called "Berylco 440", undergo dimensional changes when heattreated.

The nature and cause of these changes is a matter too complicated to warrant explanation in a simple treatise of this kind. A few fundamentals are, however, presented here with a view to pointing out observations made in practice about this phenomenon as it occurs in Cu-Be alloys, and suggestions on how it can be controlled.

1. It is a metallurgically accepted fact that during aging* of "Berylco 25", there is a maxi-

*Aging is synonymous with precipitation hardening. In the case of the alloy (Berylco 25) under discussion, standard aging temperature for maximum strength and hardness is 600°F.

mum increase in density of 0.6%. At the same time there is a maximum decrease in length of 0.2%. The corresponding increase in length due to expansion is so small at these temperatures (600°-700°F) that no perceptible difference can be expected. The net dimensional change resulting from the above, therefore, is that of shrinkage.

Several experiments performed by manufacturers of this alloy have established the fact that during heat treatment "Berylco 25" shrinks at a maximum rate of 0.003 inch per inch. The actual shrinkage in any part will depend on the internal stresses (due to cold work) of the material prior to the aging heat treatment.

Thus, an annealed material will show very little or no shrinkage during heat treatment, while a fully hardened material will exhibit the maximum shrinkage of 0.003" per inch.

2. The second fundamental is that those areas of parts to be heattreated that are under elastic or residual compressive stress, respond most quickly to precipitation hardening. This fact is in agreement with a general thermodynamic principle, Le Chatelier's Principle. Therefore, those areas that are compressively stressed, shrink first in the direction of compression and cause the parts to move permanently in this direction. Thus, the inside of a simple 90° bend or other similar bend ages first, shrinks, and causes the bend to close to a smaller angle.

3. Elastic stresses (externally induced) have a stronger influence (indicating the direction of shrinkage) than residual stresses. Thus, a part expected to have a 90° angle may be underformed intentionally to, say, 96° in the hope that the residual stresses will force the parts to close during heat treating. Such practice is not as reliable as one can expect. Instead one should subject the part to an elastic stress-fixture, to guarantee the 90° tolerance.

4. A nonuniform metallurgical structure causes nonuniform response to precipitation hardening (aging).

5. The last but not least fundamental requirement is that the furnace temperature should be controlled carefully to assure close uniformity in the entire heating area otherwise a nonuniform rate of heating will produce nonuniform results.

In view of the foregoing analysis, it is quite clear that if beryllium-copper parts are expected to maintain close tolerances, they must be made from material that is not highly stressed or else some provision should be made to prevent the kind of movement which will obviate the tolerances specified.

Metallurgically speaking, an annealed material has little or no residual stresses and a 1/4 hard material has a relatively low stress and, therefore, parts made from these materials will shrink very little during heating.

Alternatively, where feasible, a modification of tolerance requirements should be made in the original design of the part. Metallurgically uniform material can be purchased through special negotiation with vendors.

Two other alternatives are available: a. Use of "fixture" during heating, and b. Forming material after heat treating. Jig-fixturing is the only known method for completely insuring that parts will retain a particular desired shape. But jigs are expensive and impractical when several thousand small parts must be heat treated.

SUMMARY OF OBSERVATIONS:

1. Age hardenable alloy parts will undergo dimensional changes during heat treating.
2. Design engineers must take this fact into consideration when making tolerance specifications.
3. The harder the temper (stronger material) the more shrinkage (up to a maximum of 0.003"/inch) and the more distortion.
4. Shrinkage will always move in a direction in accordance with Le Chatelier's Principle. Thus, compressively stressed areas (insides of bends) will shrink and close.
5. Shrinkage can be controlled by:
   a. Using low-stressed material (annealed).
   b. Metallurgically uniform material (this is most difficult to control).
   c. Use of jig-fixtures during heat treating.
   d. Use of mill-heat-treated stock to form parts.
   e. Not heat-treating the part, i.e. using a higher temper material in order to obtain needed high strength without aging.

-Kwaku Mensah, Ext 7833
Metallurgist

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NEXT ISSUE ON MAGNETIC SHIELDING

The next issue of Materials News will be devoted to magnetic shielding with emphasis on materials and processing problems. If you would like to contribute to a better awareness of what is being done in these areas, please submit your ideas by Monday, April 20.

THE METALLURGICAL LABORATORY - A profile of Available Equipment and Services

The Met. Lab, though physically and administratively part of Electrochem Engineering, exists in reality as a companywide support unit available to all who need and can use our services.

The laboratory is equipped primarily to provide complete metallographic services (sectioning, polishing, microscopic examination and microphotography of metallic samples). Metallographic preparation of some non-metallic materials can be preformed with varying degrees of success depending upon the material and available equipment.

Other services include the following:

A. Troubleshooting:
- (1) Failure analysis (fracture, etc.) of metallic components through microstructural examination.
- (2) Failure analysis through mechanical testing (limited tensile tests) hardness and microhardness tests.
- (3) X-radiography of potted circuitry, castings and other components that cannot be destroyed. (X-ray penetration is limited.)
- (4) Fluoroscopic examination by X-ray.
- (5) Failure analysis of plating problems (blisters, and/or pitting, adhesion, etc.).

B. Control and certification:
- (1) Thickness measurement of plated and related films.
- (2) Mechanical testing--tension, compression, fatigue, hardness, microhardness, guided bend, on both metallic and non-metallic materials.
- (3) Radiography of multiple-layer circuit boards.
- (4) Chemically milled (etched) pattern certification.
- (5) Microstructure of plated films.

C. Other services:
- (1) Consultation of:
  - (a) Selection and properties of metals.
  - (b) Heat treating of metals.
  - (c) Corrosion of metals.
  - (d) Soldering, brazing and welding of metals.
  - (e) Forming of metals.
  - (f) ASTM specifications on metals.
- (2) Research type studies: Depending on the availability of time and personnel/equipment, the Met. Lab will undertake the investigation and compile a comprehensive report on any metal fabrication process or on any other metallurgically related problem such as solderability of metals; simple diffusion studies of plated, cladded or otherwise joined metals; corrosion of metals; wear of metals; etc.

Equipment available:

Metallographic sample prep.

Abrasive cut-off machine (1)-Cuts up to 2" dia.
Sample mounting press (2)-Mounts samples in bakelite and acrylic plastics.
Duo-belt grinder (1)-Two speed, wet or dry grind.
Hand grinder (1)-Four stage, 240 grit-600 grit.
Sample polishers (1)-Three stage, 6 microns-0.05 micron.
(1)-Electrolytic polisher.
Microscopes (2)-Metallugical, one microscope is capable of observations in bright field and dark field.
(1)-Stereoscopic-up to 50 X.
Metallograph (1)-Magnifications-10 X to 3000 X.
Phase contrast examinations.
Bright field/dark field observations.
Polarized light observations.
Polarized interferometric feature.
35 mm microphotography.
Grain size measuring.
Hardness testing (1)-Rockwell Twintester for both standard and superficial hardness testing.
(1)-Tukon Tester for microhardness testing with both knoop (K.H.N.) and 136' Diamond (Vickers) Indentors.
Tensile-Compressive testing (1)-Table model "Instron" Universal Tensile Tester. Maximum useful loading capacity-600 lbs.
Wear resistance testing (1)-Sand abrasion tester.

Non-destructive testing:

Radiography: (1) Field Emission pulsed X-ray, portable-110 KV and 150 KV; penetration-0.125" steel; exposure compartment-16" h., 11.5" w., 14.0" d.; cassete capacity-12 x 14".
(1) Field Emission (standard) X-ray, portable-10 to 130 KV; exposure compartment-14.5"h., 18.25"w., 15.5"d.; cassete capacity-14" x 17" max.
Plated film thickness (1) Betascope measurements.

Specific inquiries regarding metallurgical laboratory services are welcomed. Please direct such inquiries to Kwaku Mensah.

-Kwaku Mensah, Ext 7833
Electrochem

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