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White Paper:

The Use of Reclaimed Phenolic Pistons in Remanufactured Brake Calipers

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Overview

Brake calipers are among the sturdiest components on a vehicle, but calipers do occasionally require service or replacement. If a failure occurs, technicians will often replace unserviceable brake calipers with remanufactured units.

Extreme care must be taken when remanufacturing a brake caliper. Each reusable component must be thoroughly inspected and carefully evaluated before being reconditioned, and all rubber seals, boots, bushings and abutment clips - as well as all phenolic pistons - must be replaced with new components because of the possible failures associated with reusing those components.

Caliper Failures

The symptoms of caliper failure may include a loss of pressure, steering pull during brake application, a rattling or clunking noise, and in many cases, a squealing or grinding noise as the brakes are applied. Caliper failures can be attributed to many factors including failing seals, bleeder issues, corrosion or other damage.

Brake Caliper Service

Brake calipers, like disc brake rotors, are more easily replaced than serviced. Since a caliper's main casting is rarely damaged, remanufacturing or rebuilding of brake calipers is an industry norm.

Difference Between Remanufactured and Rebuilt/Reclaimed

Rebuilt or *reclaimed* calipers are disassembled, cleaned and rebuilt using new or reused components (image 1).

Image 1: Damaged phenolic pistons have been reused in this caliper.

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Centric Parts *Remanufactured* brake calipers undergo a much more involved process. The caliper casting, pistons and seals are the most important components in this process. Each caliper core is inspected and identified, then disassembled and all rubber seals and boots are discarded. If present, phenolic pistons are also discarded.

Each reusable component – such as the caliper body and bracket, steel or aluminum pistons, guide bolts and guide pins -- is inspected, cleaned and refinished to ensure maximum life. After the caliper casting is disassembled, cleaned, media-blasted and deemed suitable for remanufacturing, the brake hose inlets are knurled (where needed) for proper sealing and all threaded holes are chased. Final assembly is done using new OE quality components – such as rubber seals, boots, bushings and abutment clips -- before being pressure tested for leaks to ensure Centric remanufactured calipers perform as new.

Phenolic Pistons

Caliper pistons are manufactured of phenolic plastic, aluminum or steel. "Phenolic" refers to a variety of hard plastic that is exceptionally strong and heat resistant. Phenolic pistons reduce heat transfer into the brake fluid, resist corrosion that could cause caliper binding and are lightweight.

Risks of Reusing Phenolic Pistons

Phenolic pistons are able to withstand high compression stresses and extreme temperatures, but like any mechanical component, phenolic materials are susceptible to degradation over time, especially when exposed to conditions beyond their original intended useful range. Over time, excessive overheating or unexpected side loads can compromise and damage phenolic pistons (image 2).

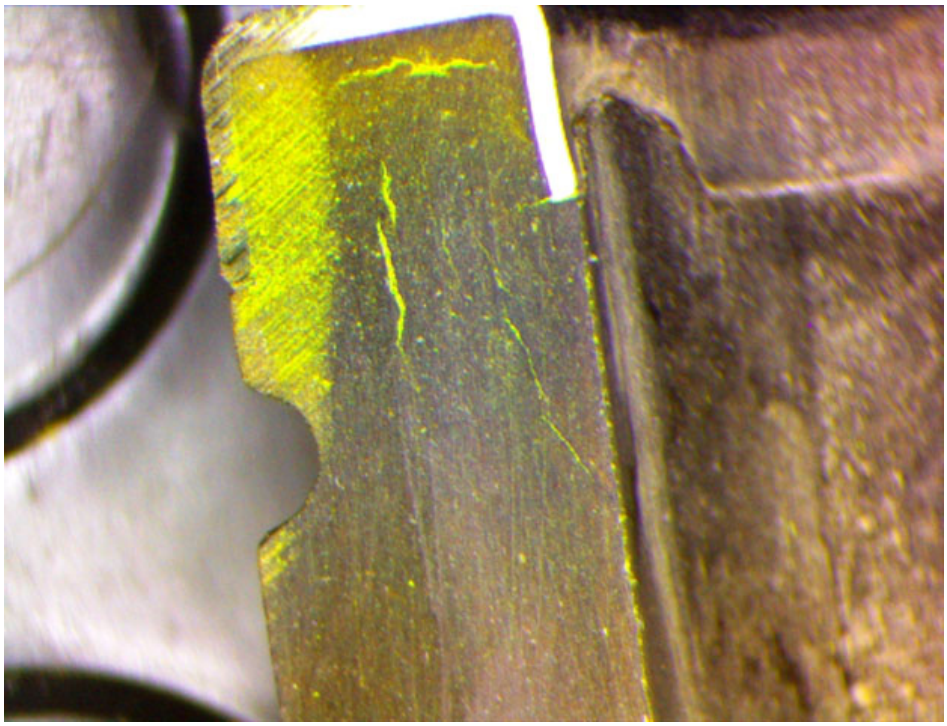

Image 2: Cutaway of used phenolic piston, using dye to highlight damage that would be difficult to see with the naked eye.

Any possible heat damage and stress cracking of a phenolic piston cannot easily be determined or identified through normal non-destructive inspection processes. Visual inspections only reveal typical appearance issues such as cracking, chipping or decay. Visual inspections cannot predict the internal condition of the phenolic material.

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Due to the unknown history of a used caliper, the condition of the phenolic pistons cannot be predicted. There are several types of possible damage that are hard to predict or determine through a visual inspection.

- Distortion
  - Fluid Absorption and Distortion -- Phenolic pistons are Hygroscopic. This means they have a strong tendency to absorb moisture from the atmosphere. When a piston is not in the vehicle and is exposed to the environment it will absorb moisture and change size, especially in extremely humid environments.
- Cracking
  - Mishandling During Remanufacturing - Phenolic pistons are very strong in compressive loadings, in a fixed structure like a caliper. However, phenolic pistons are very sensitive to side loads of any sort. Phenolic piston manufacturers advise that if a piston is dropped during production, that piston must be scrapped. The typical tear down process and handling in remanufacturing does not support the careful management of re-used/reclaimed phenolic pistons.
  - Seal Failure -- When a seal fails it will likely twist the piston in the bore, seizing it in place, causing a side load (stress) which can crack or chip the piston. Often, these cracks are not visible to the naked eye.
  - Overheating -- As evidenced in image 2 above, a piston that looks in good condition through visual inspection can actually exhibit internal cracks due to the brakes being overheated. These cracks will continue to worsen and due to the high compressive forces, have the potential to eventually cause the piston, and ultimately the caliper, to fail.
  - Notch Sensitivity – The tendency of a phenolic piston to fracture under load, particularly impact, is increased by the presence of a surface inhomogeneity such as a notch or sharp inside corner, a sudden change in thickness, a crack, and/or a scratch.
    - It is not uncommon for technicians to force pistons back into the caliper using pliers (Image 3). The result will often be a deformation of the cap that may hide a notched or cracked piston below it.

Image 3: Dented and pitted caps; most likely the result of forcing the piston into the caliper with pliers

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- Material Degradation
  - High Heat Cycles -- Subjected to extended high heat cycles (such as repeated long descents with brakes applied), phenolic material may “over cure” and become brittle, increasing sensitivity to cracking. Visually there would be little to no elongation or distortion prior to failure (images 4 and 5). Failure is not predictable by physical change.

Image 4: Damage to this used piston from an external visual inspection appears to be minimal and contained to the steel cap.

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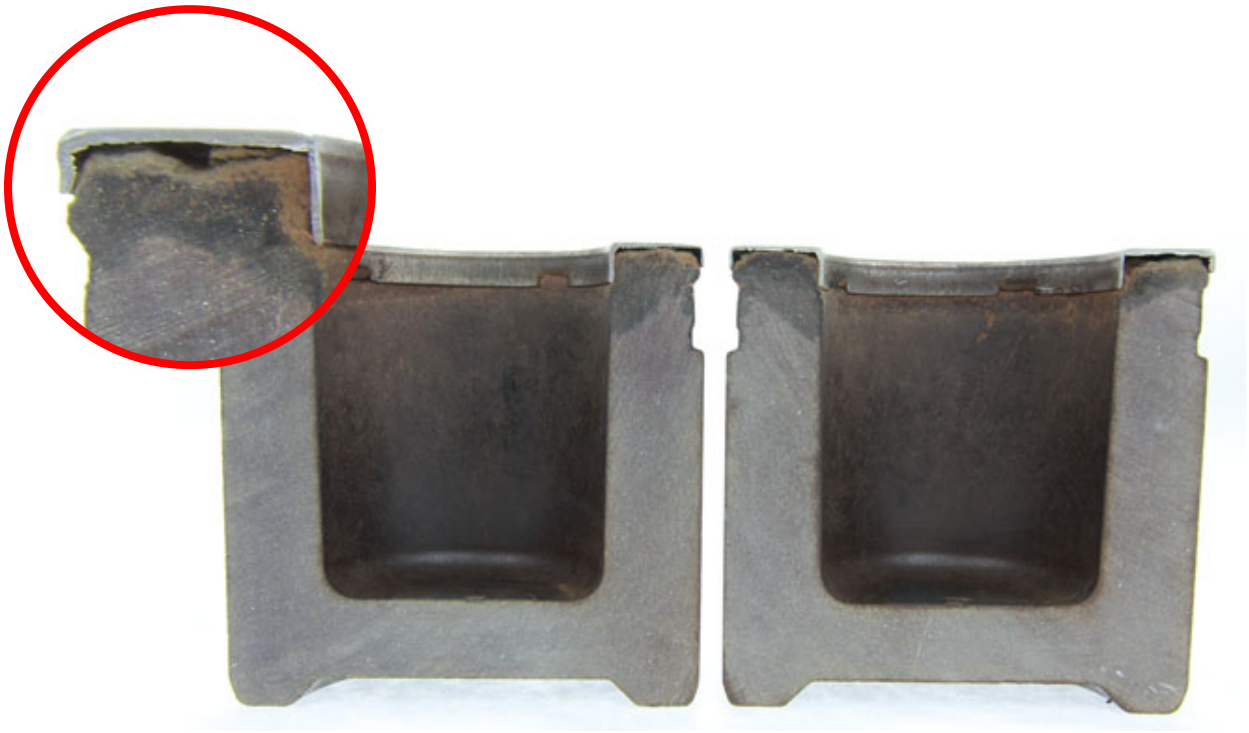

Image 5: Slicing the piston in half reveals degradation and darkening of the phenolic material under the cap - the result of prolonged excessive heat exposure.

Phenolic Failures

When unseen internal or external damage causes excessive cracking in a phenolic piston, several outcomes are possible:

- Uneven pad wear due to degradation of piston crown
- Heat shield corrosion, allowing phenolic to decompose through excessive exposure to heat.
- Cracked piston would likely lead to a loss of pressure and complete brake failure

In summary, a properly “remanufactured” caliper equipped with phenolic pistons, will include new phenolic pistons. Visual inspections that would be performed during a typical rebuilding cycle are inadequate to identify potential internal damage and by their very nature, more thorough inspections would result in the destruction of the pistons. The potential risk is far too great to reuse phenolic pistons.

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APPENDIX 1: Examples of damaged phenolic pistons being reused in reclaimed calipers

Image 6: Pitted and corroded caps

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Image 7: Severe corrosion of the cap depositing rust into the piston

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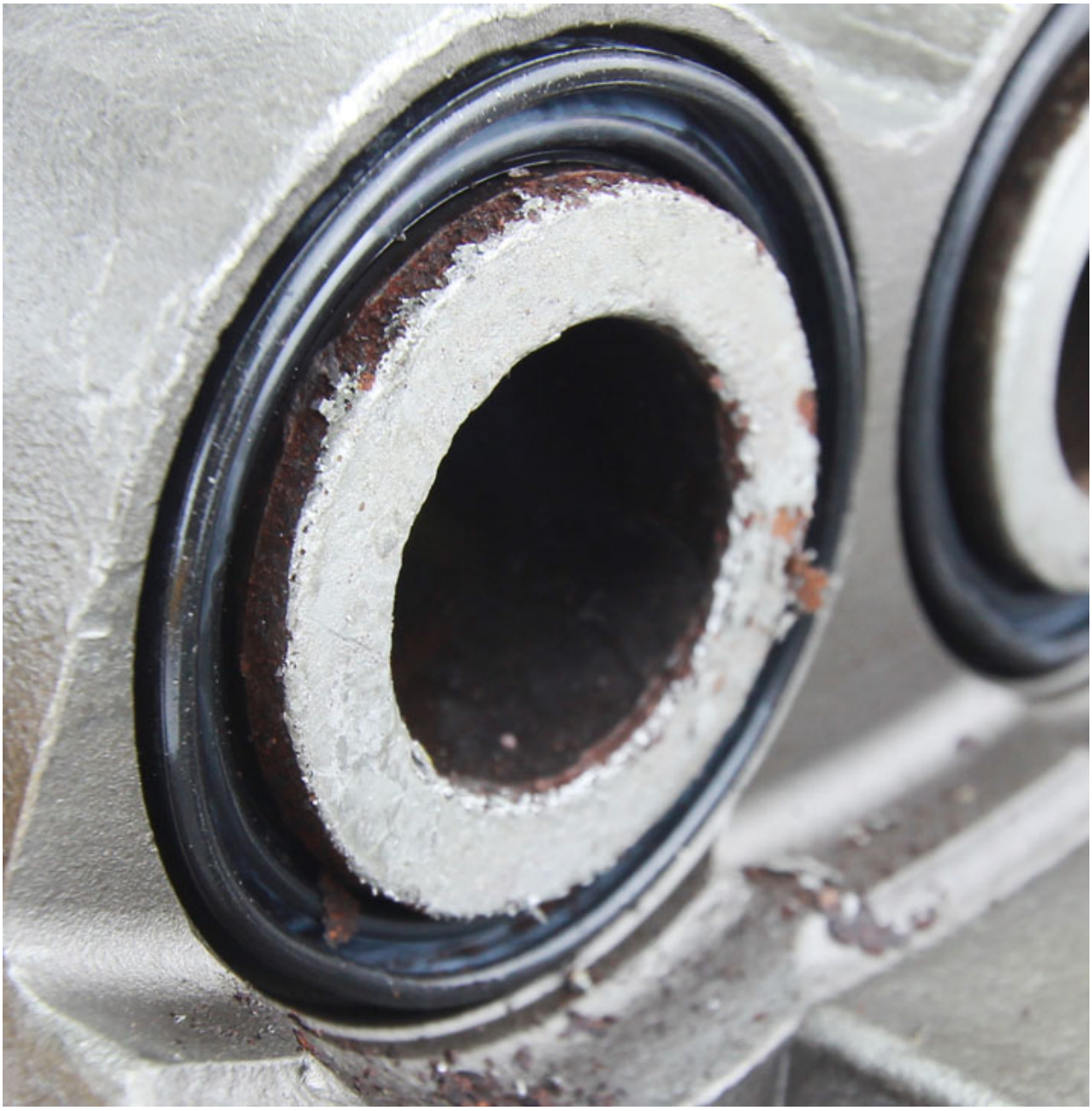

Image 8: Severely corroded cap is flaking apart