

IRMC 2023

Stator core repair by electro-etching

Case study

Osmo Koponen, 21.4.2023

TGS Finland Oy

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- Also companies TGS Sweden and TGS Germany
- TGS = Turbines, Generators, Systems
- We work on service and expert services of gas and steam turbines, all generators, electrical motors and related automation and control systems (e.g. power plant automation, excitation and protection)
- Scandinavia, Baltic countries, Central Europe, UK...

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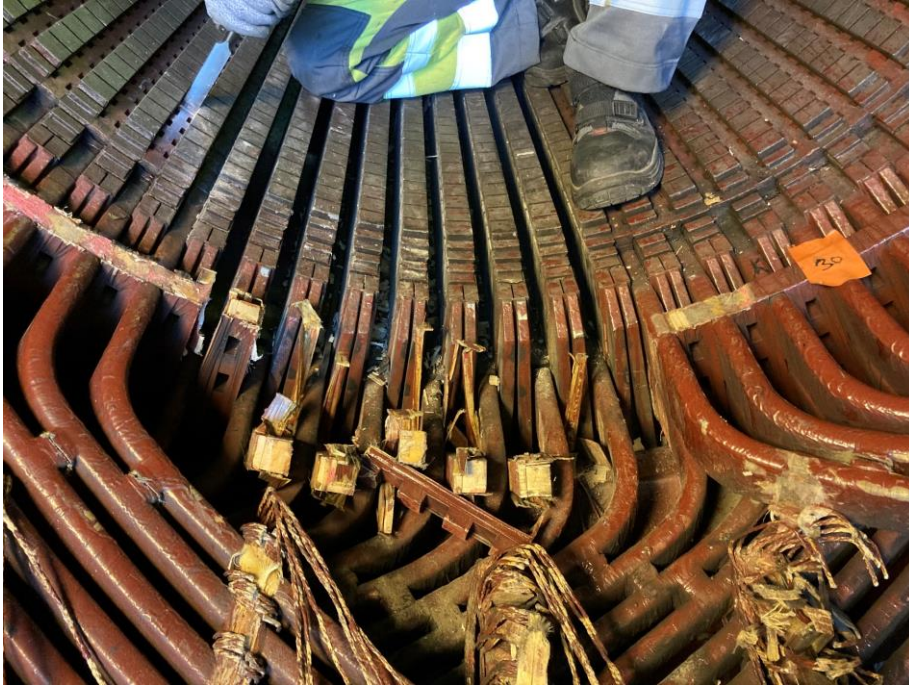
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Turbo generator winding failure and rewinding



120 MVA 10,5 kV
3000 rpm

Problem

- Damages on the bottom of stator core slot, caused by forced removal of stuck stator winding bar. Damaged length approximately 40 cm.



Problem

- ELCID measurement indicates a problem, possibly 5-10 °C hot spot
- $I_{\text{QUAD}} = 130 \text{ mA}$

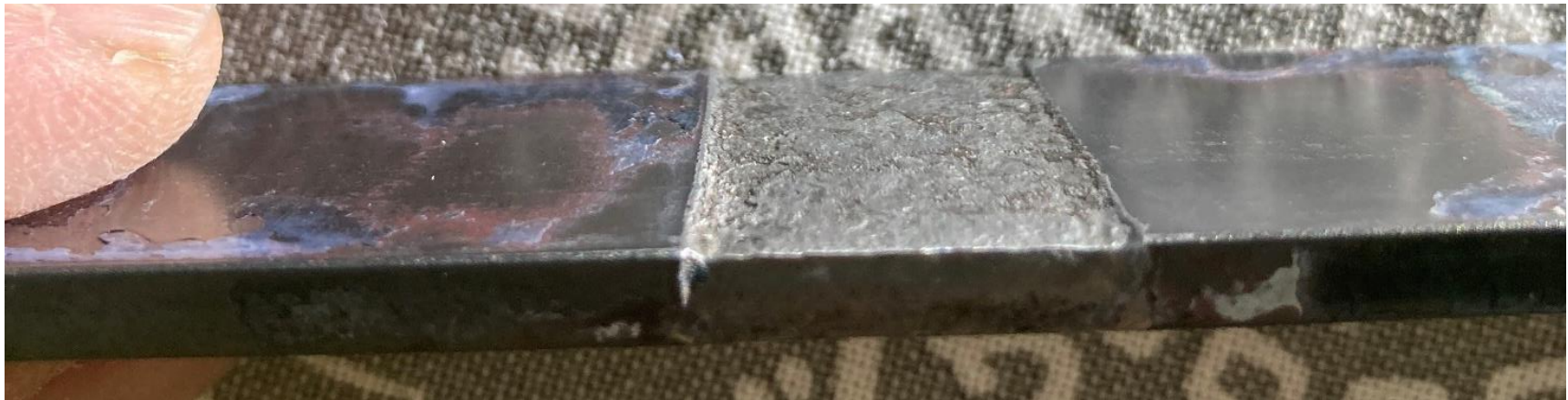


Solution

- Electro-etching process described in "Handbook of Large Turbo-Generator Operation and Maintenance" by Klempner and Kerzenbaum
- Removes thin layer of steel
- Electrolysis:
 - Electrolyte: 25 % phosphoric acid – water solution
 - Cathode (minus): stainless steel, is not eroded
 - Anode (plus): stator core
 - DC current
- Phosphoric acid is not toxic in moderate concentration; you drink it every time you drink Coke or Pepsi
- It is still acid and damages skin and especially eyes, protection is needed
- You can buy 75 % phosphoric acid from hardware store; it is used as rust removal agent and does not damage steel without electrolysis

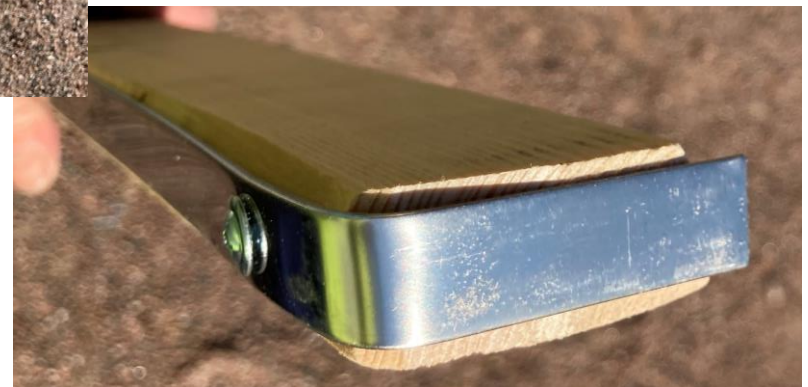
Solution

- Testing etching on a piece of structural steel
- Area 30 mm x 18 mm was etched appr. 4 h with low 2 A DC current, which removed some 0,2 – 0,3 mm of the steel surface
- Removed iron becomes iron phosphate dissolved in the electrolyte, not toxic in moderate concentration



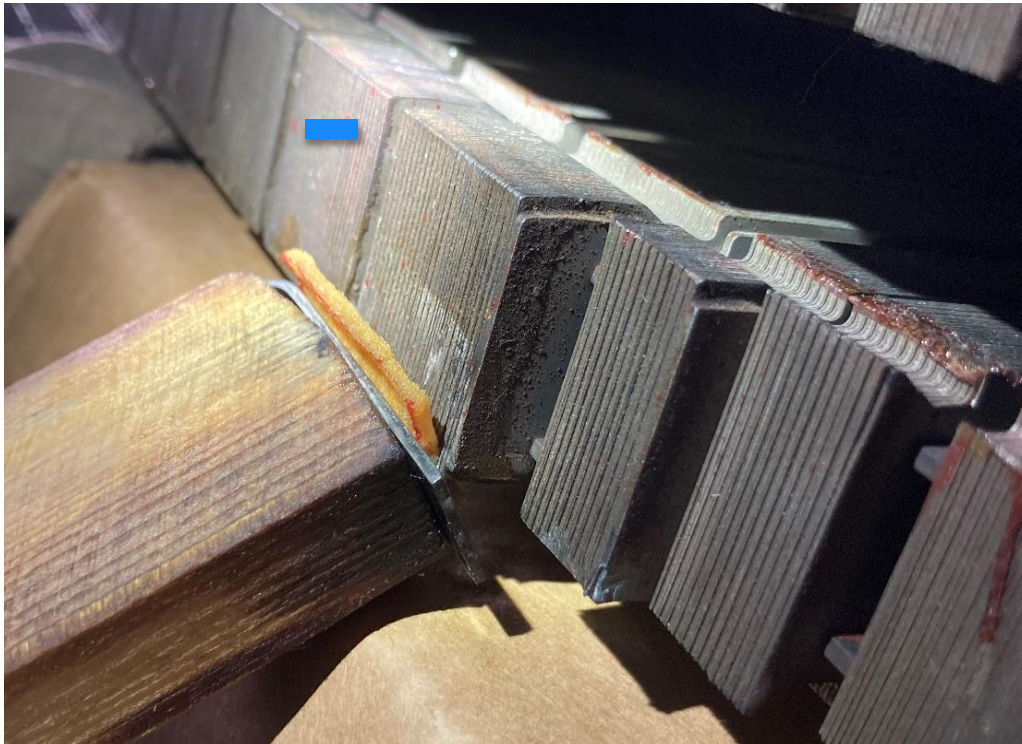
Process

- Tool was made with correct dimensions to reach the bottom of the slot
- Cathode electrode is made of stainless steel and does not corrode



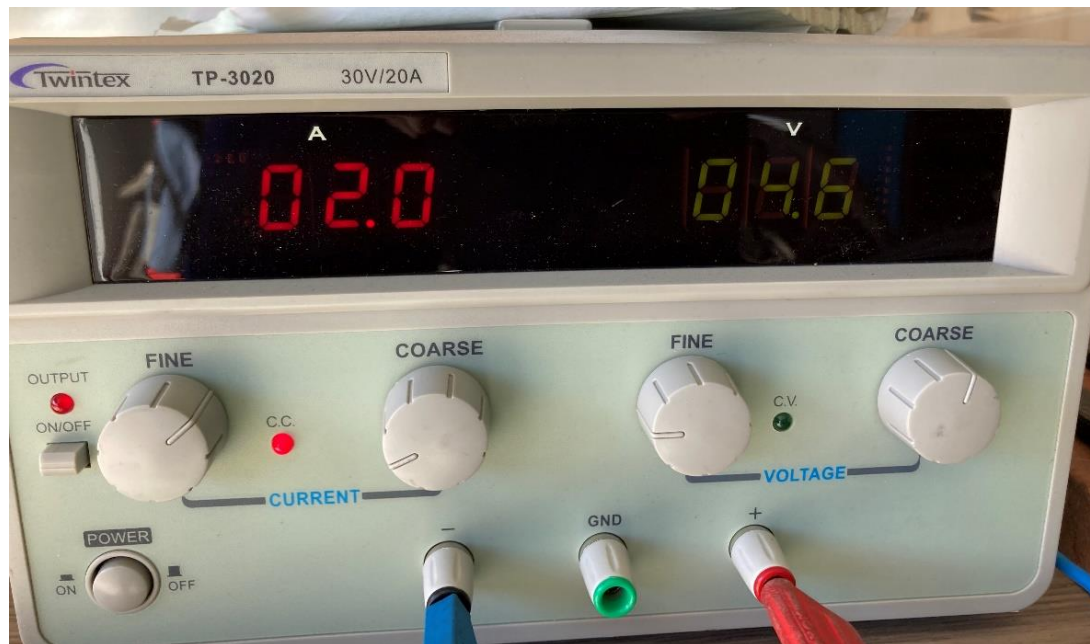
Process

- Wooden stick holds the stainless steel cathode, piece of cloth holds the electrolyte (has to be changed in every 10 minutes or so)
- DC source supplies the current ($< 10\text{ A}$, $< 10\text{ V}$)

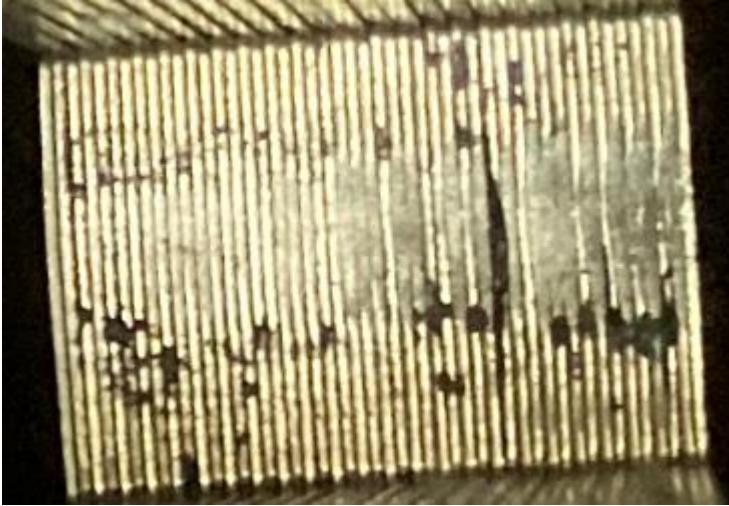


Process

- DC source supplies the current, here $< 10\text{ A}$, $< 10\text{ V}$ but depends on the size of the area
- DC source here is just inexpensive laboratory source



Result



BEFORE

AFTER



Result

- No longer fault indication in ELCID



Conclusions

- Suitable for shallow surface damages, also large areas
- You can fully control start, stop and speed with the current
- Removes steel but leaves the insulation between core laminations
- You can easily remove maybe up to 0,3 mm steel
- If deeper damage, machine it first and then etch the machined surface to remove burrs
- Not suitable for buried fault spots

Thanks for your time!

