TEST:

POSSIBLE STAINING ON

NICKEL PLATED SURFACES

EKWB Internal Report

1.Reason and testing methods

Since the introduction of Electroless Nickel plating (EN), few concerns have been raised in various forums about the accumulation of dirt on the surface of nickel. All customers experiencing similar occurrences on nickel surfaces, stated they have been using distilled water with or without algaecide with no corrosion inhibitors.

To investigate the effect of the variety of liquids most commonly used in cooling loops, a comprehensive test was carried out incorporating seven different test systems.

Each loop consisted of:
- EN Nickel plated block – EK-FC590 GTX (10um+ nickel plated coating)
- Galvanic Nickel Plated water block – EK-FC580 + EK-FC570 GTX SE (10um+ nickel plated coating)
- Flushed radiator
- New EK-DCP 2.2 pump
- New EK Reservoir
- New TUBE Masterkleer 12,7/9,5 CLEAR
- New EK barbed fittings

During the test period the nickel surfaces were periodically monitored for any evidence of discolouration or build-up of residue. All blocks in a loop have a nickel coating layer of at least 10 microns thickness (0.01 mm)

Loop #	Liquid
1.	Distilled water
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)
3.	Distilled water + silver coil
4.	Ekoolant blue premix
5.	Ekoolant Blue concentrate mixed with distilled water 1:9.
6.	Ekoolant clear
7.	Fluid XP

2. Results

2.1. Deposits/Discolouration

LEGEND:

✖ - no staining present
✓ - some staining is shown
✓✓ - minor staining on entire surface is shown
✓✓✓ - moderate staining is present
✓✓✓✓ - heavy staining is present

1 week:

First signs of dirt deposits/discoloration started showing after 1 week within the following loops:

Loop #	Liquid	EN Nickel	Galvanic Nickel
1.	Distilled water	✓	✗
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)	✓	✗
3.	Distilled water + silver coil	✓	✗
4.	Ekoolant blue premix	✗	✗
5.	Ekoolant Blue concentrate mixed with distilled water 1:9.	✗	✗
6.	Ekoolant clear	✗	✗
7.	Fluid XP	✗	✗

Comment: The deposits/discoloration started to show only on the EN nickel plated blocks in the systems without anticorrosion additive. Blocks with galvanic nickel plating have not shown any changes.

3 weeks:

Signs of dirt deposits/discoloration showing after 3 weeks within the following loops:

Loop #	Liquid	EN Nickel	Galvanic Nickel
1.	Distilled water	✓✓	✗
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)	✓✓	✗
3.	Distilled water + silver coil	✓✓	✗
4.	Ekoolant blue premix	✓	✗
5.	Ekoolant Blue concentrate mixed with distilled water 1:9.	✓	✗
6.	Ekoolant clear	✓	✗
7.	Fluid XP	✓	✗

Comment: The deposits/discoloration increased within loops 1, 2 and 3 on the EN nickel blocks, while the rest of the loops started showing minor signs of the deposits/discoloration after 3 weeks, but only on the EN nickel plated blocks. Blocks with galvanic nickel plating have not shown any changes.

4 weeks:

Signs of dirt deposits/discoloration showing after 4 weeks within the following loops:

Loop #	Liquid	EN Nickel	Galvanic Nickel
1.	Distilled water	✓✓✓	✓
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)	✓✓✓	✓
3.	Distilled water + silver coil	✓✓✓	✓
4.	Ekoolant blue premix	✓	✓

5.	Ekoolant Blue concentrate mixed with distilled water 1:9.	✓	✓
6.	Ekoolant clear	✓	✓
7.	Fluid XP	✓	✓

Comment: The deposits/discoloration have significantly increased within loops 1, 2 and 3 on the EN nickel plated blocks where no anticorrosion additive was used. Minor discoloration is showing within all other loops.

8 weeks:

Signs of dirt deposits/discoloration showing after 8 weeks within the following loops:

Loop #	Liquid	EN Nickel	Galvanic Nickel
1.	Distilled water	✓✓✓✓	✓
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)	✓✓✓✓	✓
3.	Distilled water + silver coil	✓✓✓✓	✓
4.	Ekoolant blue premix	✓	✓
5.	Ekoolant Blue concentrate mixed with distilled water 1:9.	✓	✓
6.	Ekoolant clear	✓	✓
7.	Fluid XP	✓	✓

Comment: The deposits/discoloration were visibly increasing through the weeks within loops 1, 2 and 3 on the EN nickel plated blocks where no anticorrosion additive was used. Deposits/discoloration were slightly increasing also within all of the other loops.

12 weeks:

Signs of dirt deposits/discoloration showing after 12 weeks within the following loops:

Loop #	Liquid	EN Nickel	Galvanic Nickel
1.	Distilled water	✓✓✓✓	✓
2.	Distilled water + Copper Sulphate based algaecide (2 drops/l)	✓✓✓✓	✓
3.	Distilled water + silver coil	✓✓✓✓	✓
4.	Ekoolant blue premix	✓	✓
5.	Ekoolant Blue concentrate mixed with distilled water 1:9.	✓	✓
6.	Ekoolant clear	✓	✓
7.	Fluid XP	✓	✓

Comment: The deposits/discoloration within loops 1, 2 and 3 on the EN nickel plated blocks where no anticorrosion additive was used, were so intense that we decided to take all the loops apart and try to clean them. See cleaning results in Chapter 3.

3. CLEANING RESULTS

We have taken pictures of all blocks after 12 weeks of usage in our test systems. Blocks have been partially cleaned either with a cotton cloth only or PUROL ® - universal polishing paste for metals.

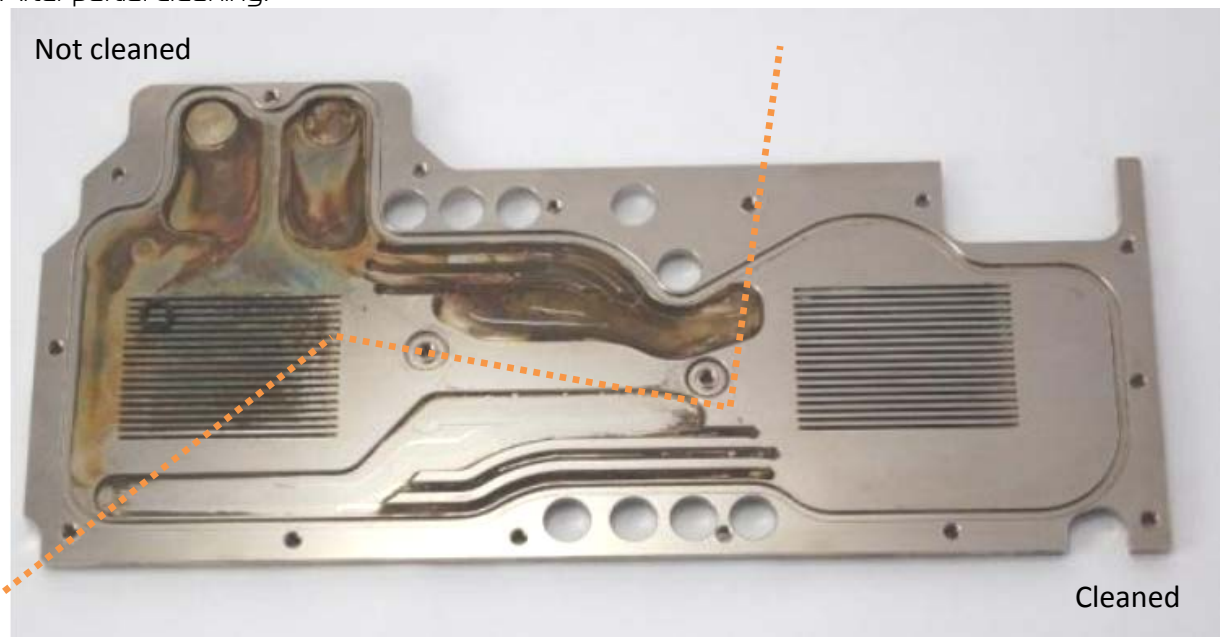
3.1. System #1 – Pure Distilled Water

3.1.1. Electroless Nickel plated block (EN)

Before cleaning:

The stains/deposit on the nickel plated surface were clearly thick and ugly.

After partial cleaning:



3.1.2. Dirt was difficult to remove from recessed areas. Polishing paste was used.

Galvanic Nickel plated block

Before cleaning:

The discoloration/deposit on the nickel plated surface was not previously found in only distilled water systems. The discoloration/staining is very likely because of the high discoloration/staining of the EN block in the same loop, although much less intense. A standalone system has already been set up to exclude any influences from EN blocks on the nickel plated block.

After partial cleaning:

Cleaning was easy compared to EN block version.

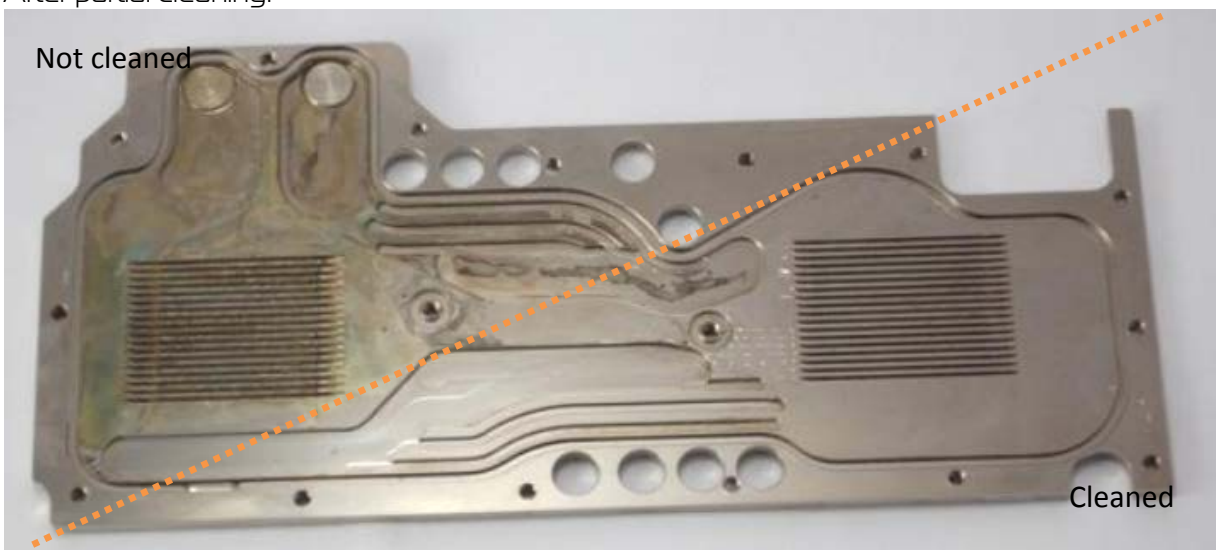
3.2. System #2 – Distilled Water with Copper Sulphate based biocide

3.2.1. Electroless Nickel plated block (EN)

Before cleaning:

Before cleaning, the surface had similar but less intense discoloration/deposit compared to that observed in the distilled water only loop.

After partial cleaning:



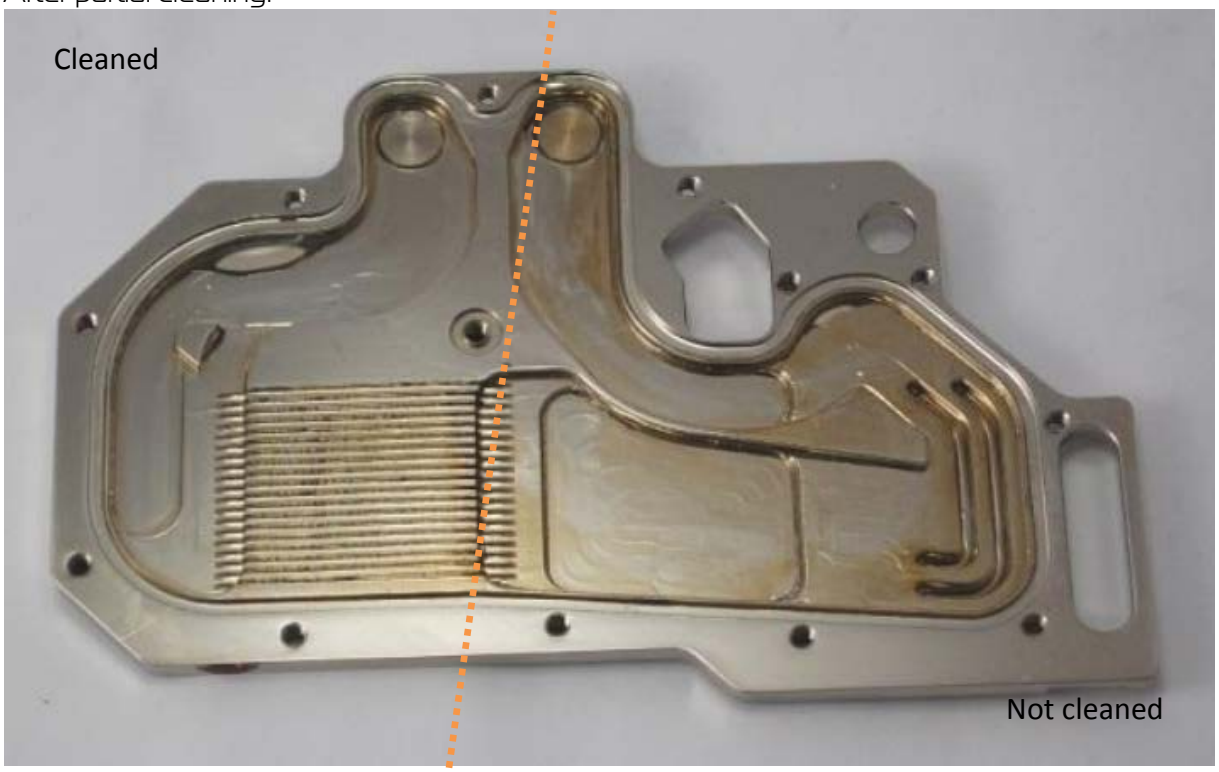
The degree of staining itself was lower when compared to that observed in the distilled water only loop. Cleaning was uncomplicated using the polishing paste, however using a paper towel alone was not sufficient to clean the surface.

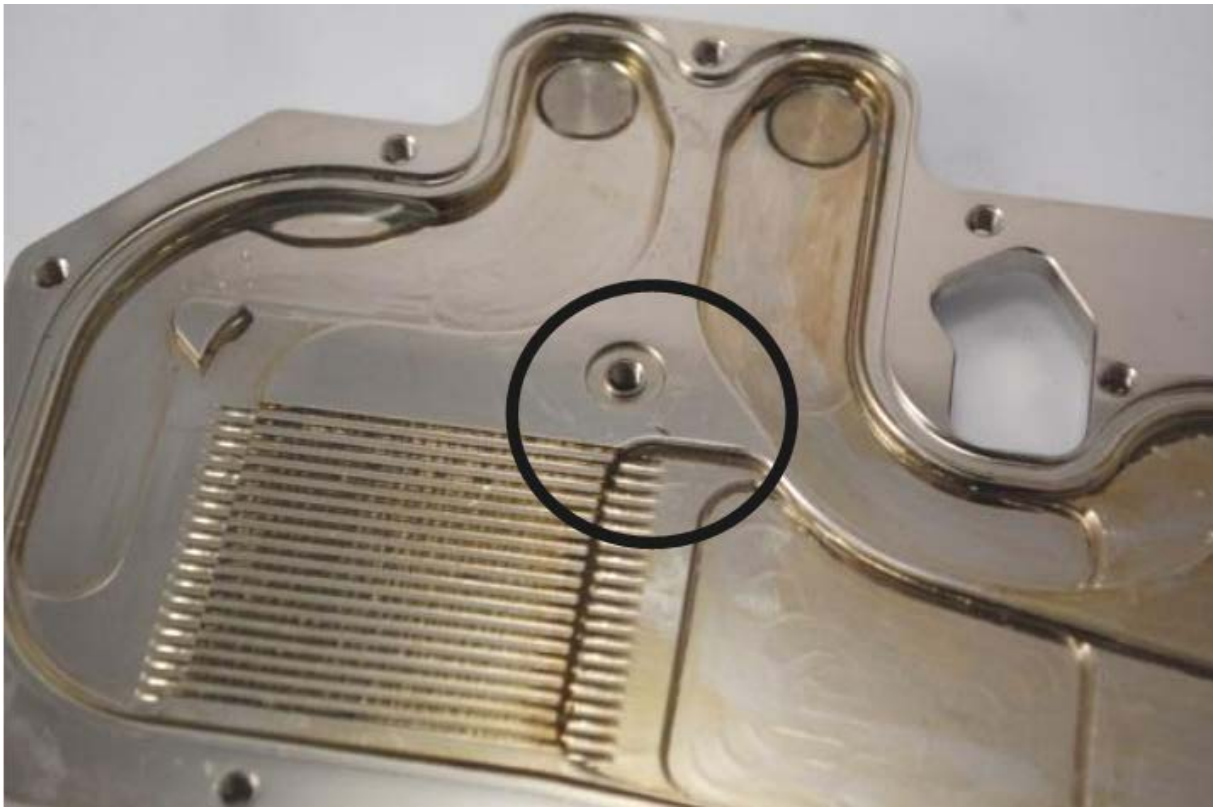
3.2.2. Galvanic Nickel plated block

Before partial cleaning:

The block was cleaned using the polishing paste, as a paper towel alone was not sufficient to clean the surface. The result was as expected. There were already signs of possible corrosion at the those places where water flow is minimal – between the top and nickel plated base. The discoloration/staining is very likely because of the high discoloration /staining of the EN block in the same loop.

After partial cleaning:





After cleaning the corrosion of the nickel plating was confirmed. The cleaning of the other surface was relatively easy.

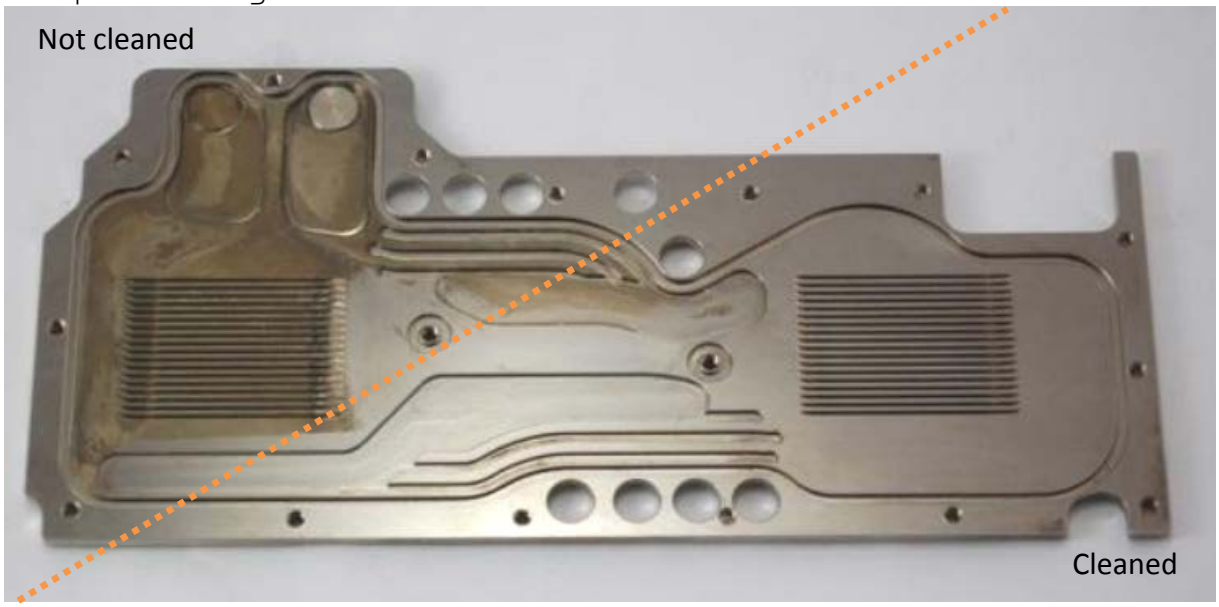
3.3. Distilled water + Silver coil

3.3.1. Electroless nickel plating (EN)

Before partial cleaning:

Before cleaning, the surface had similar discoloration/deposit when compared to the loop using distilled water only and the loop with Copper Sulphate based biocide.

After partial cleaning:



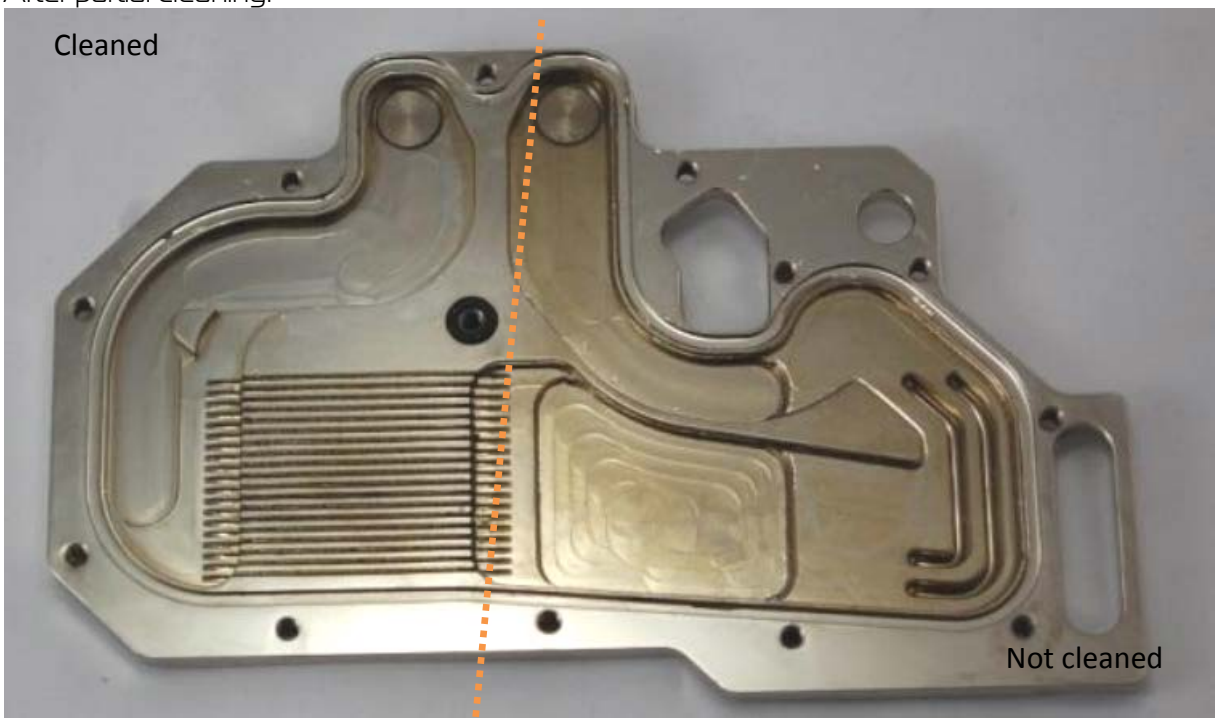
Cleaning was made by polishing paste and was pretty easy. Using a paper towel alone was not sufficient to clean the surface.

3.3.2. Galvanic nickel plating

Before partial cleaning:

The discoloration/staining is very likely because of the high discoloration/staining of the EN block in the same loop.

After partial cleaning:



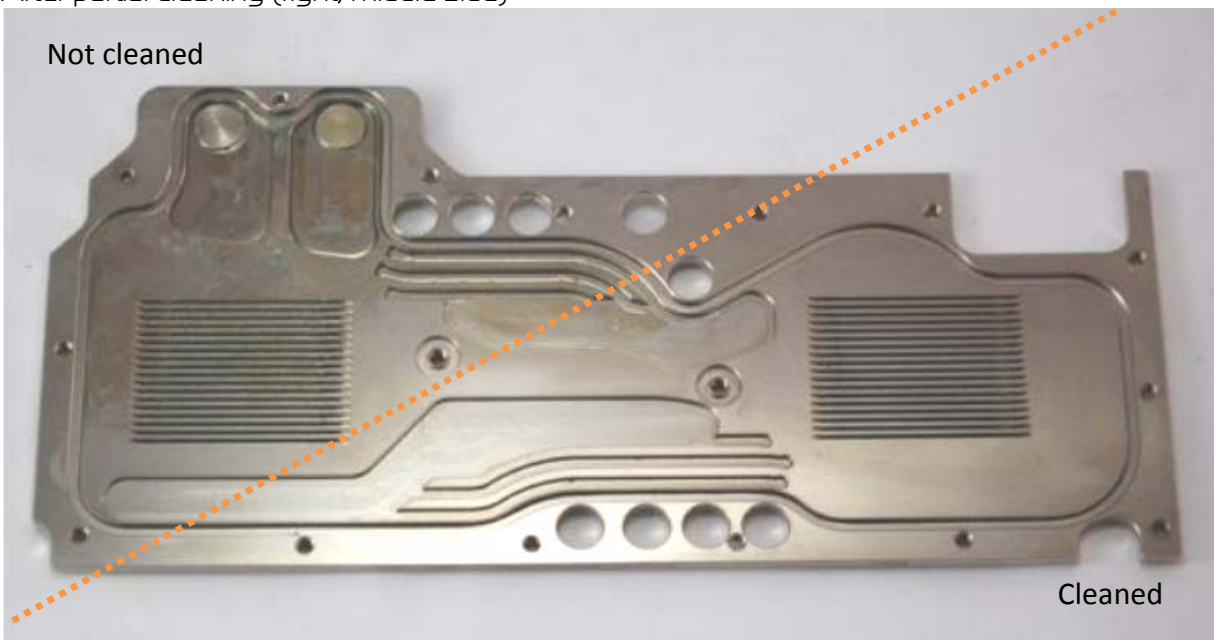
Cleaning with polishing paste needed little effort. Using a paper towel alone was not sufficient to clean the surface.

3.4. Loop #4 – EK-Ekoolant Blue premix

3.4.1. Electroless nickel plating (EN)

Before partial cleaning

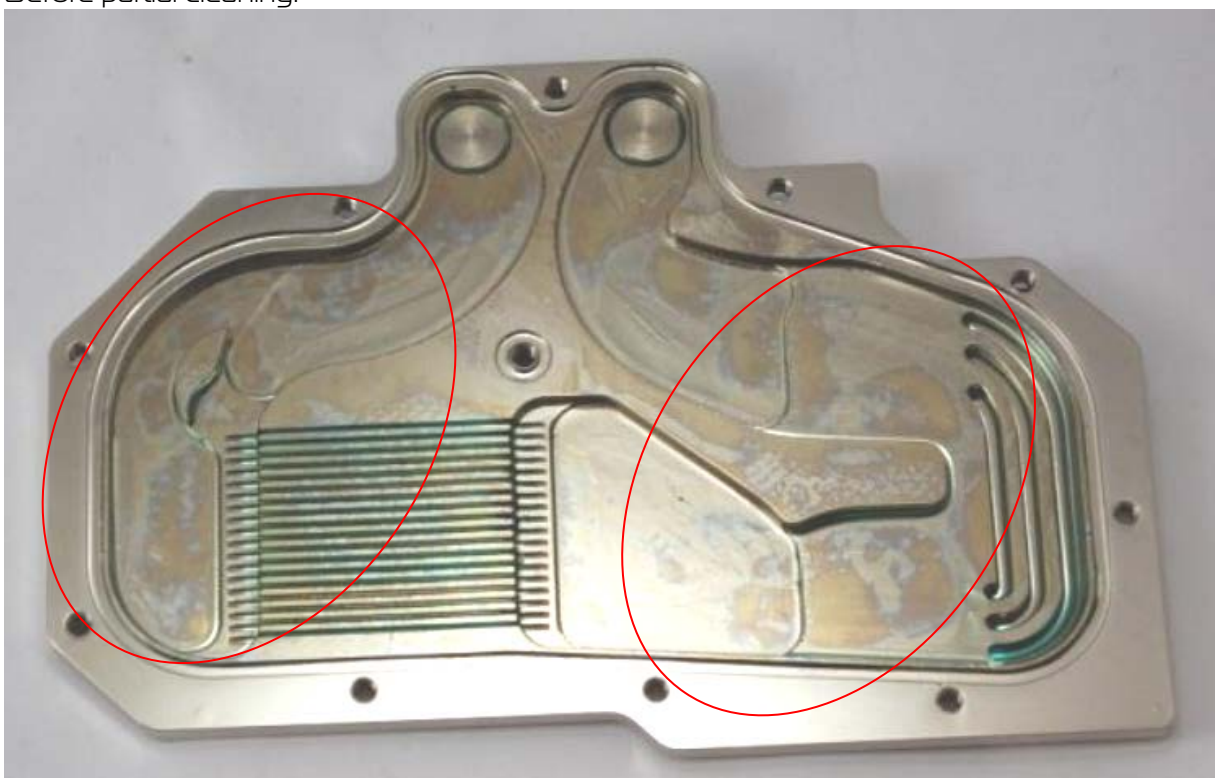
After partial cleaning (right, middle side)



The area where we used Ekoolant was easily cleaned by wiping with a paper towel. Discoloration was minimal and is likely to have been caused by glycol.

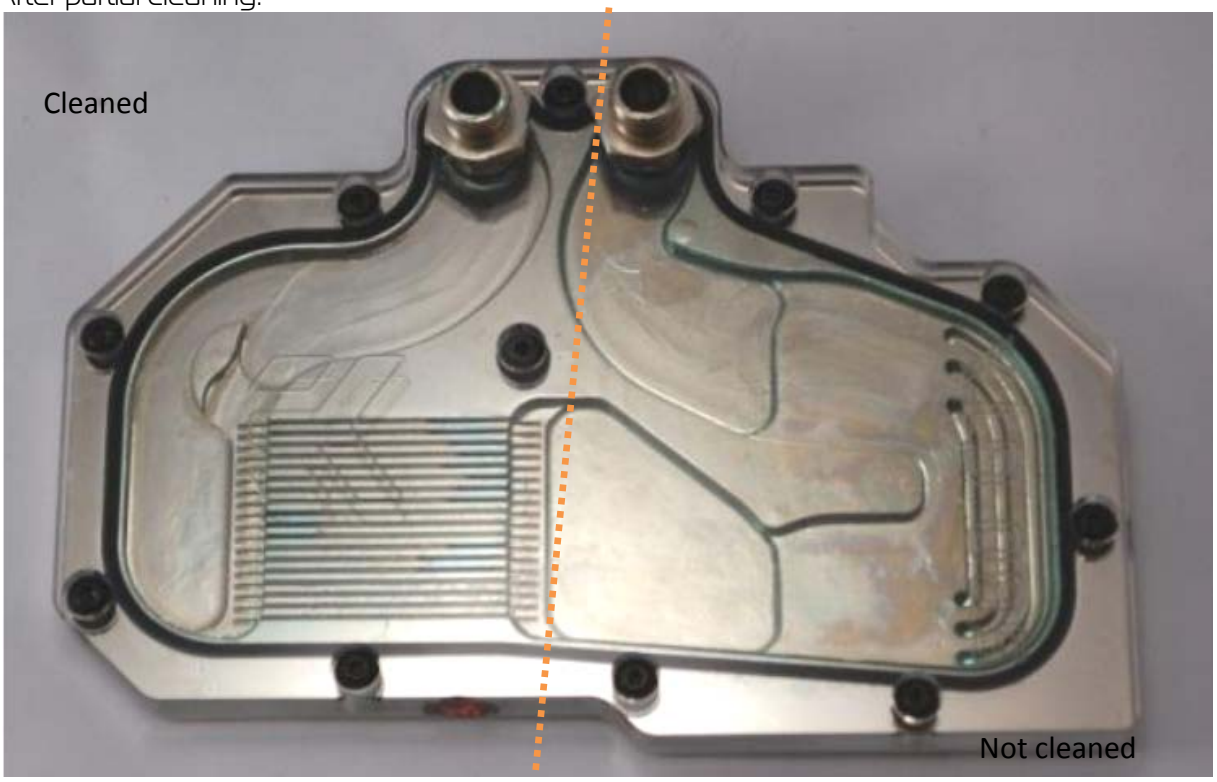
3.4.2. Galvanic nickel plating

Before partial cleaning:



After opening the block, only a layer of drying coolant was left on the surface. The blue of the coolant is showing in the recessed areas where more of the blue coolant remained.

After partial cleaning:

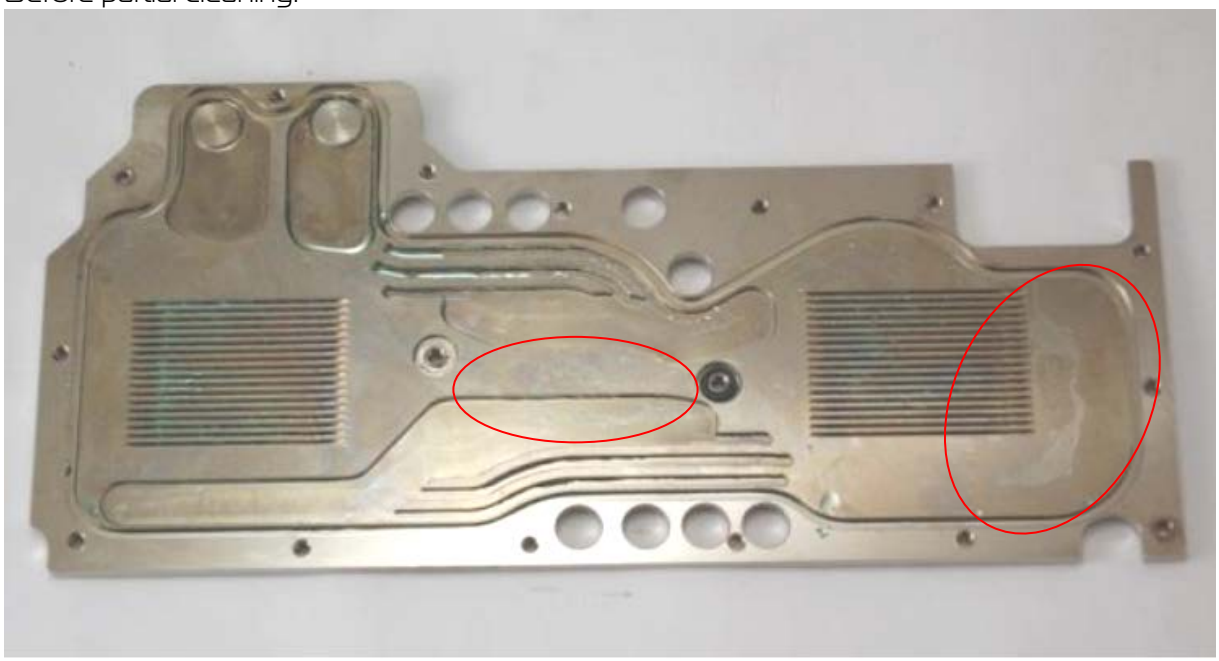


The area where we used Ekoolant was easily wiped by a paper towel. Discoloration is insignificant.

3.5. Loop #5 – EK-Ekoolant Blue concentrate (100ml + 900 ml distilled water)

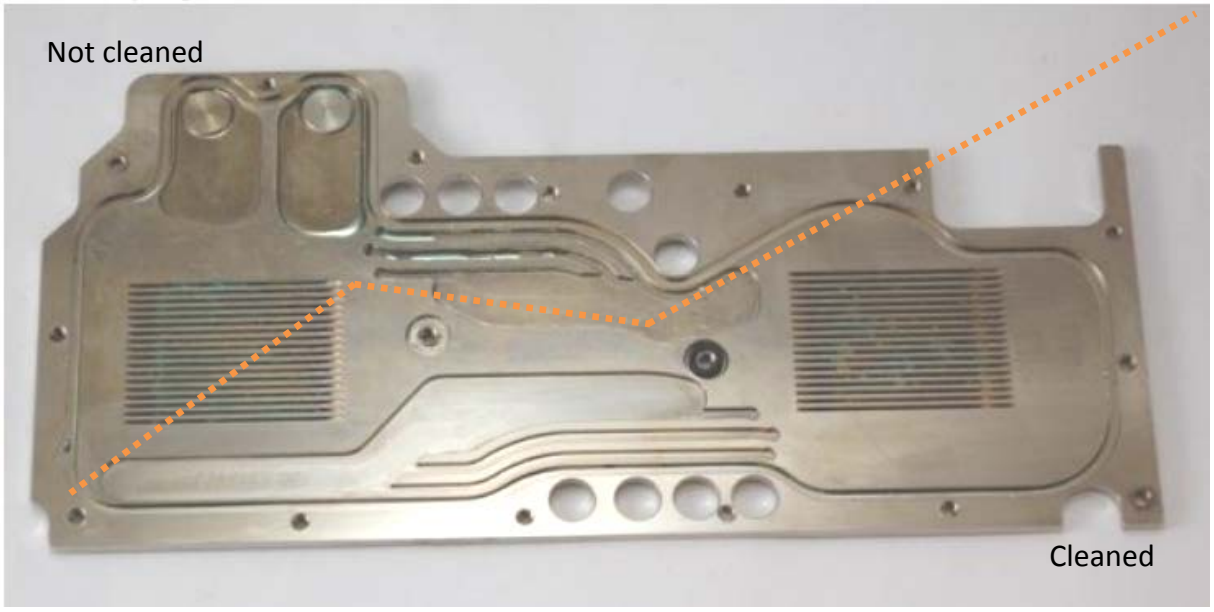
3.5.1. Electroless nickel plating (EN)

Before partial cleaning:



On the surface, only minor stains/discoloration can be seen caused by the drying layer of coolant. The slight blue cast that can be seen is due to the Blue Coolant.

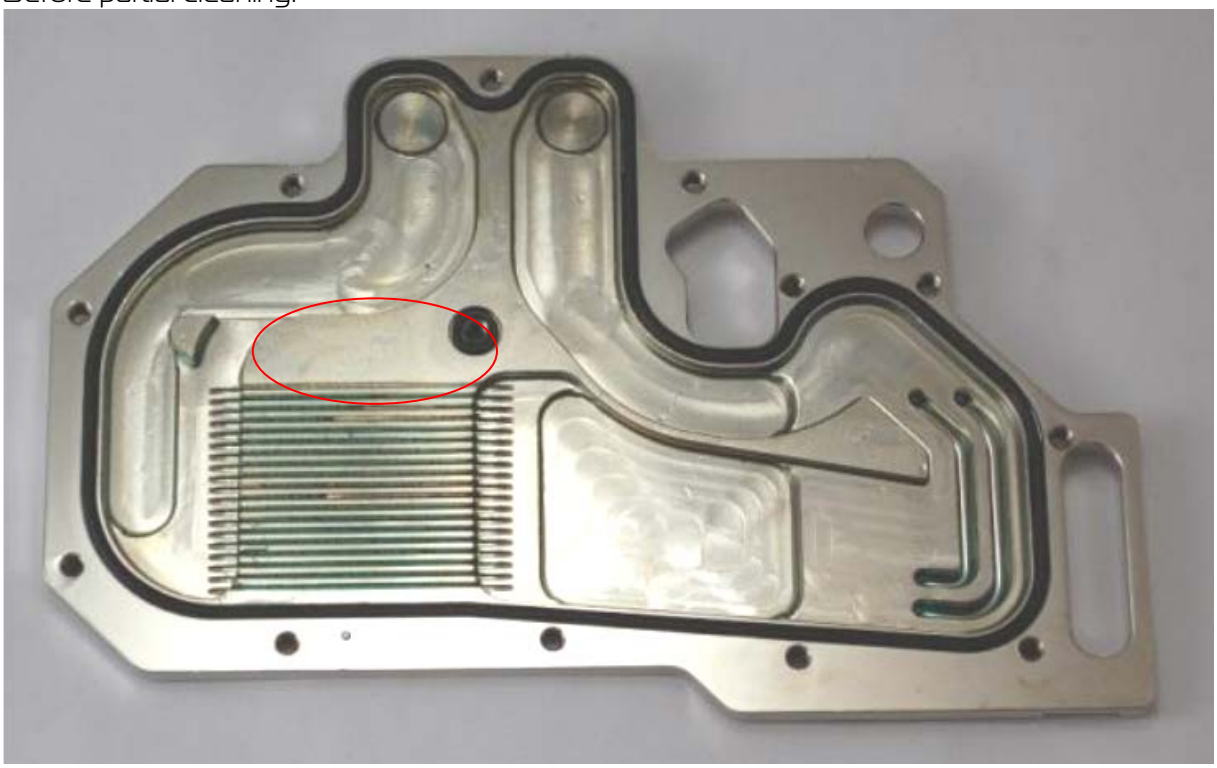
After partial cleaning:



The internal channels of the block where Ekoolant was flowing were easily wiped by a paper towel. Discoloration is minimal.

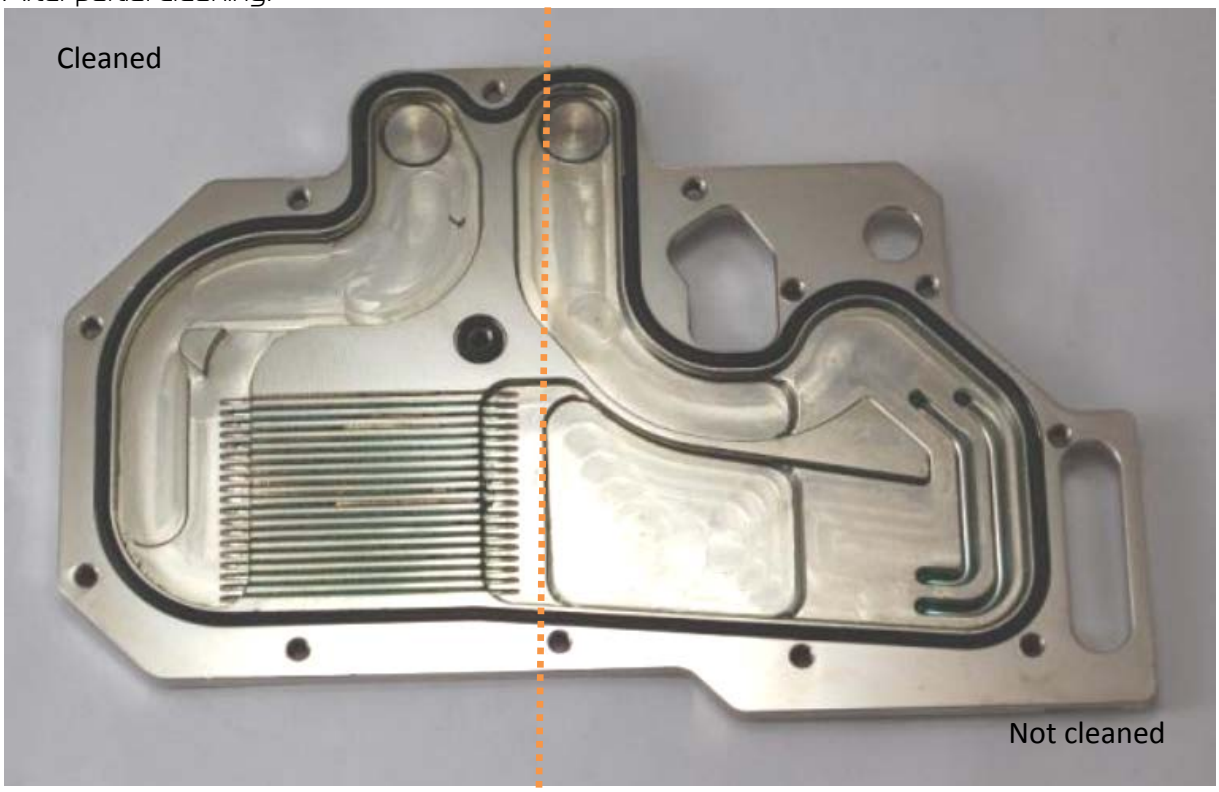
3.5.2. Galvanic plating

Before partial cleaning:



On the Galvanic nickel plated block used in the loop with Ekoolant, only minor staining/discoloration was detected.

After partial cleaning:



The areas where Ekoolant remained were easily wiped by a paper towel. No staining or discoloration remained after wiping.

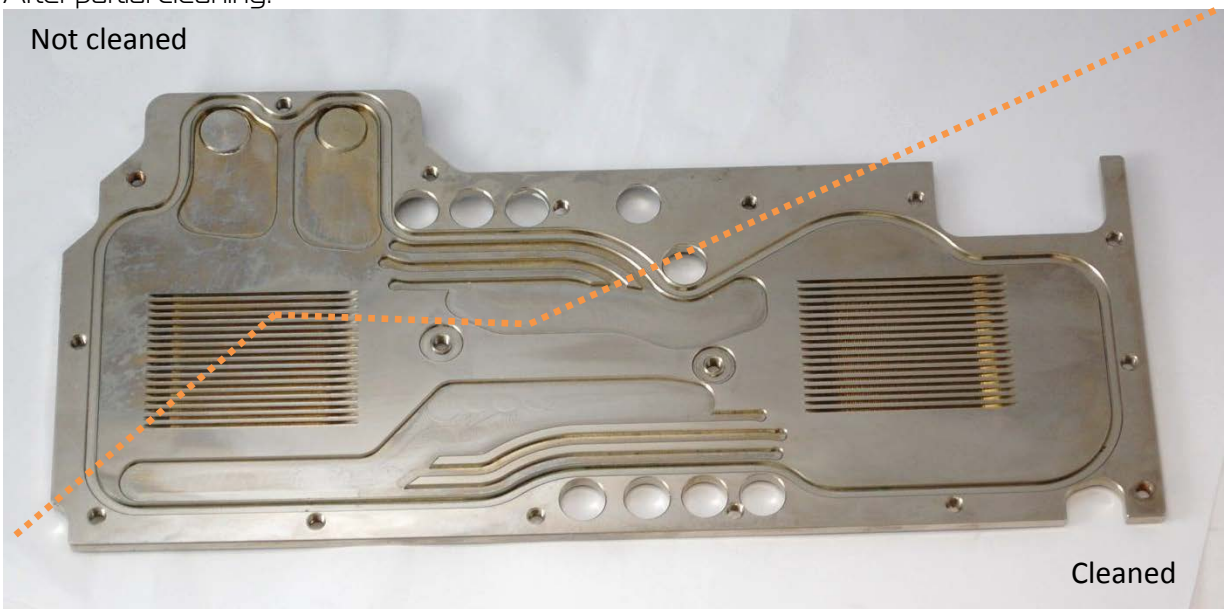
3.6. Loop #6 – EK-Ekoolant Clear premix

3.6.1. Electroless nickel plating (EN)

Before partial cleaning:

Only minor stain/discoloration can be seen on the surface, caused by the drying layer of coolant.

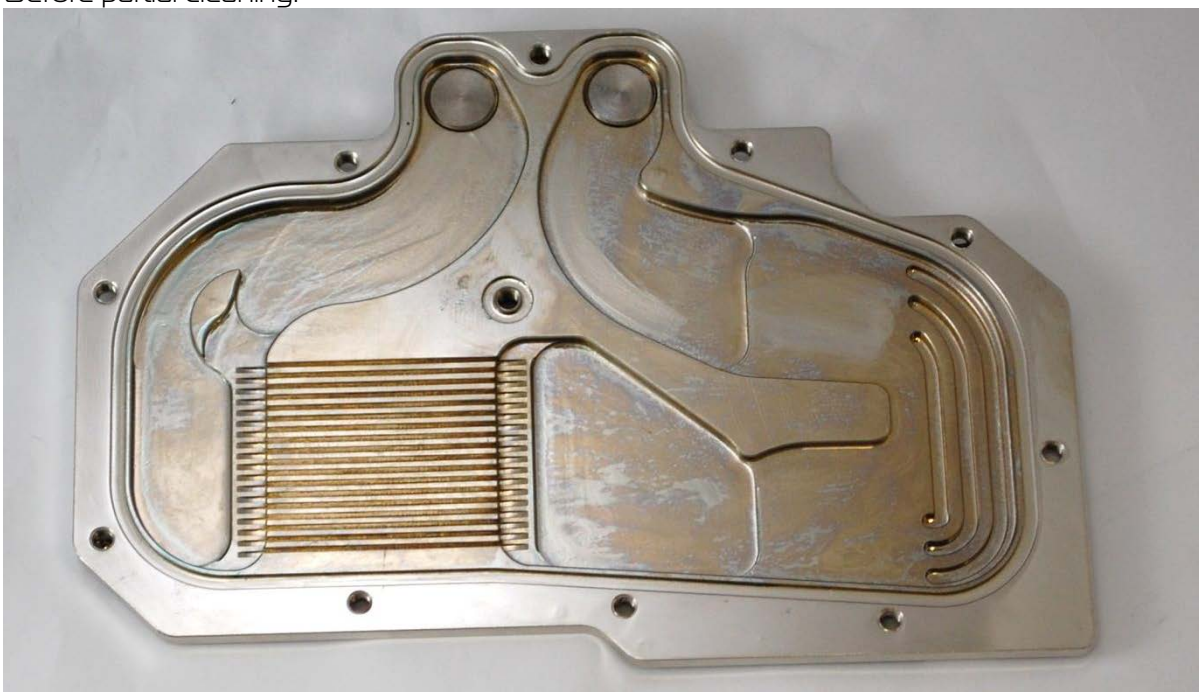
After partial cleaning:



The block was easy to clean with a paper towel, and the original surface gloss was restored. No staining or discoloration remained after wiping.

3.6.2. Galvanic nickel plating

Before partial cleaning:



The dirt on the surface on the nickel plating was mainly dried coolant.

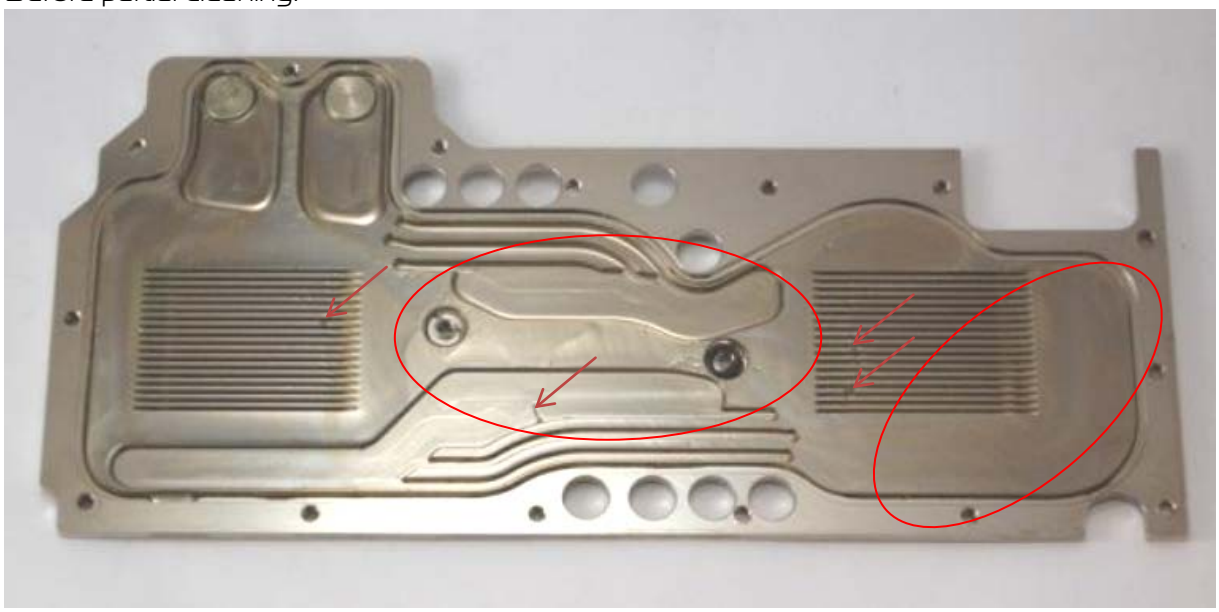
After partial cleaning:

The block was easily cleaned with a paper towel, and the original surface gloss was restored. No staining or discoloration remained after wiping.

3.7. Loop #7 – Fluid XP Clear

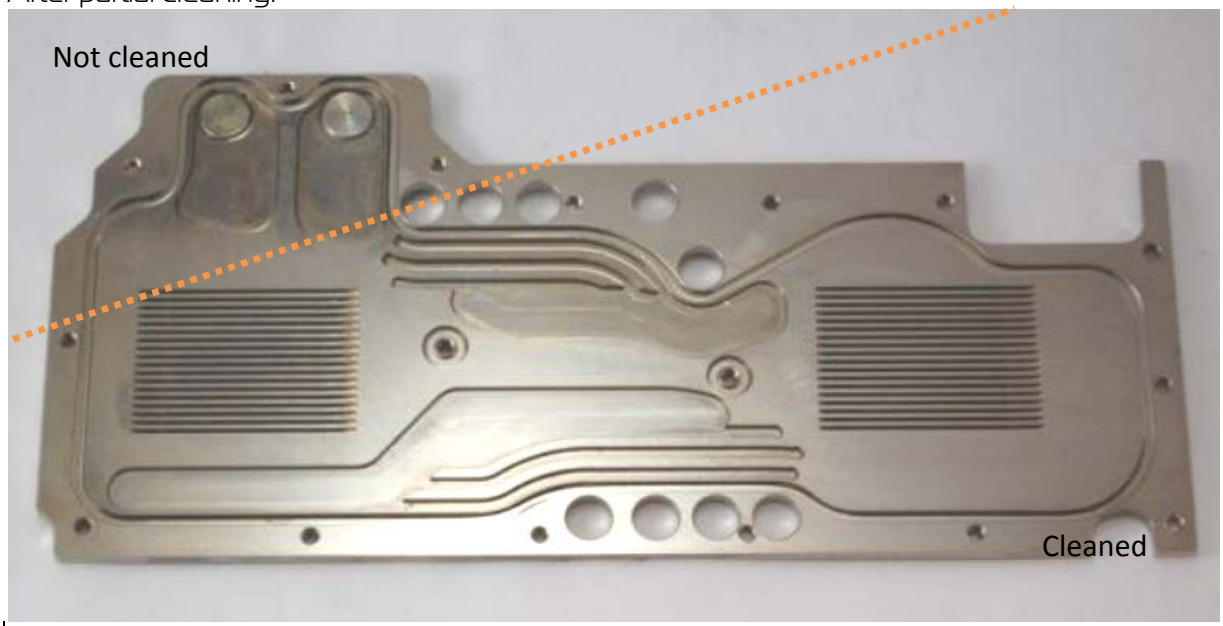
3.7.1. Electroless Nickel Plating (EN)

Before partial cleaning:



No excessive dirt/discoloration was found on the surface. However, we have found traces of gunking which appears to be plasticizer from the tubing (see red arrows).

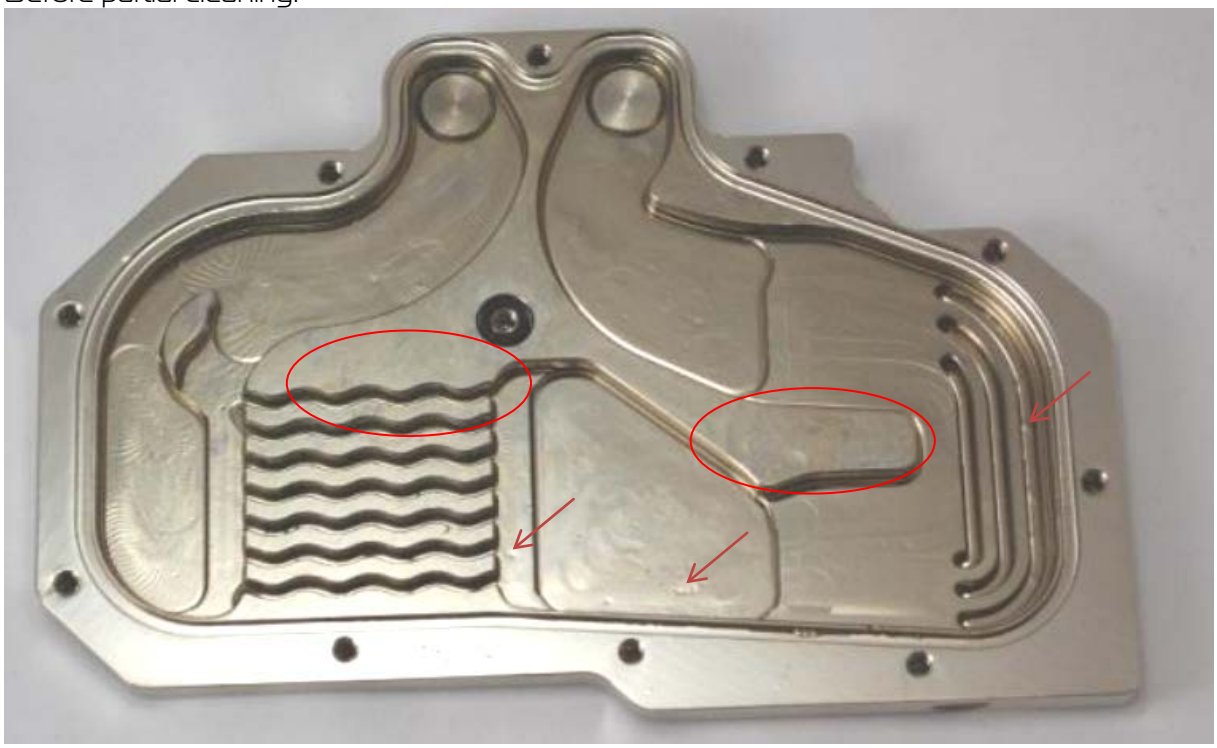
After partial cleaning:



Cleaning the block was easy, although less so than in the loops where Ekoolant was used.

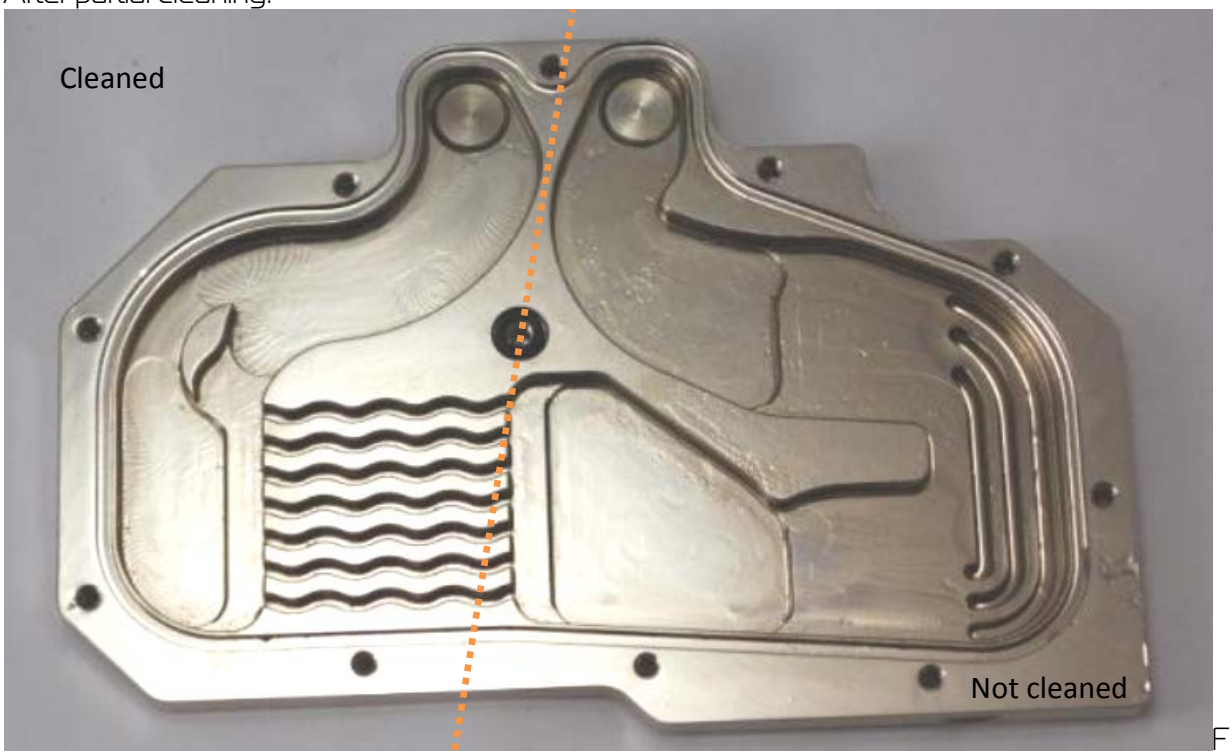
3.7.2. Galvanic Nickel Plating

Before partial cleaning:



There was no excessive staining/dirt deposits found. However, we have found traces of gunking which appears to be plasticizer from the tubing.

After partial cleaning:



Fluid XP does not leave excessive marks. Cleaning was easy with paper towel.

4. Conclusion

Although distilled water has excellent cooling characteristics, because it has no additives it enables dirt deposits and is a potential time bomb for corrosion (which is also shown in analysis carried out by the Jozef Stefan institute).

Regardless of the better anti-corrosion resistance of EN compared to the galvanic plating, the surface became much dirtier (staining/discoloration) after the use of distilled water without anticorrosion additives. Some deposits might also have been the result of plasticizer leakage, coming from tubes. EKWB strongly recommends the use of coolants, such as EK-Ekoolant which was tested along with similar coolants such as Thermochill EC6. Fluid XP proved to be satisfactory, but due to its alcohol content, it is not recommended for use with EK products.

For further reading, educational articles on distilled water can be found on following links:
http://martinsliquidlab.org/2012/01/02/distilled-water-is-the-king-of-water-cooling/
http://martinsliquidlab.org/2012/01/24/corrosion-explored/
http://en.wikipedia.org/wiki/Distilled_water
http://www.corrosionistforum.com/public/showthread.php?tid=19
http://www.overclockers.com/pc-water-coolant-chemistry-part-i/
http://www.overclockers.com/pc-water-coolant-chemistry-part-ii/
http://skinneelabs.com/coolantfluid-roundup-thermal-performance/
https://www.cedengineering.com/upload/Cooling%20Water%20Problems%20and%20Solutions.pdf