

Chemical composition of geothermal water and heated groundwater for space heating from geothermal power plants in the Hengill area

Typical concentrations ($\mu\text{g/L}$) of several trace elements in geothermal water (separated and condensed water) and heated groundwater (for space heating) from the Hellisheidi and Nesjavellir Geothermal Power Plants and their maximum permissible concentrations ($\mu\text{g/L}$) for potable water. When the chemical content of separated water is compared to potable water standards, one can see that in separated water from the Hellisheidi Geothermal Power Plant, the concentration of arsenic is about four times higher and the concentration of selenium is twice the permissible levels for potable water. In separated water from the Nesjavellir Geothermal Power Plant, the concentration of arsenic is about six times higher than permissible levels for potable water. The concentration of other substances in separated water is lower than the given limits for potable water. Concentrations of trace elements in condensate and heated groundwater from both power plants is lower than the given limits for potable water.

| Element | Unit | Max. recommended value for potable water | HELLISHEIDI | | | NESJAVELLIR | | |
|-----------------|-----------------|--|-----------------|------------------|--------------------|-----------------|------------------|--------------------|
| | | | Separated water | Condensate water | Heated groundwater | Separated water | Condensate water | Heated groundwater |
| Arsenic (As) | $\mu\text{g/L}$ | 10 | 37.10 | <0.05 | 0.16 | 58.30 | 0.09 | 2.93 |
| Barium (Ba) | $\mu\text{g/L}$ | 700 | 0.33 | 0.03 | 0.58 | 0.25 | 0.07 | 0.49 |
| Cadmium (Cd) | $\mu\text{g/L}$ | 5 | 0.00 | <0.002 | <0.002 | <0.002 | <0.002 | 0.00 |
| Cobalt (Co) | $\mu\text{g/L}$ | * | 0.03 | 0.01 | 0.02 | 0.02 | 0.05 | 0.01 |
| Chrome (Cr) | $\mu\text{g/L}$ | 50 | 0.07 | 0.10 | 0.14 | 0.43 | 3.87 | 0.36 |
| Copper (Cu) | $\mu\text{g/L}$ | 2000 | 0.40 | <0.1 | 0.80 | 2.47 | <0.1 | 0.66 |
| Mercury (Hg) | $\mu\text{g/L}$ | 1 | <0.002 | <0.002 | <0.002 | <0.002 | 0.01 | <0.002 |
| Manganese (Mn) | $\mu\text{g/L}$ | 50 | 0.61 | 0.23 | 0.50 | 1.26 | 1.73 | 0.16 |
| Molybdenum (Mo) | $\mu\text{g/L}$ | * | 4.69 | <0.05 | 0.20 | 2.62 | <0.05 | 0.54 |
| Nickel (Ni) | $\mu\text{g/L}$ | 20 | 0.17 | 0.74 | 0.87 | 2.44 | 4.47 | 0.19 |
| Phosphorus (P) | $\mu\text{g/L}$ | 5000 | <1 | <1 | 39.10 | <1 | <1 | 43.20 |
| Lead (Pb) | $\mu\text{g/L}$ | 10 | <0.01 | 0.03 | 0.05 | 0.01 | 0.03 | 0.01 |
| Titanium (Ti) | $\mu\text{g/L}$ | * | 0.08 | 0.02 | 0.19 | 0.06 | 0.03 | 0.27 |
| Antimony (Sb) | $\mu\text{g/L}$ | 5 | 2.35 | 2.35 | 0.01 | 0.27 | 0.03 | 0.08 |
| Selenium (Se) | $\mu\text{g/L}$ | 10 | 15.30 | <0.5 | <0.5 | 7.60 | <0.5 | 1.95 |
| Strontium (Sr) | $\mu\text{g/L}$ | * | 4.31 | 0.06 | 10.80 | 2.11 | 0.10 | 18.20 |
| Vanadium (V) | $\mu\text{g/L}$ | * | 4.20 | 0.02 | 7.79 | 2.46 | 0.05 | 21.50 |
| Zink (Zn) | $\mu\text{g/L}$ | 3000 | 0.30 | 1.58 | 5.59 | 8.19 | 2.39 | 4.73 |

*Maximum limits not specified in potable water regulation

Chemical composition of geothermal water (separated and condensed water) and heated groundwater (for space heating) from the Hellisheidi and Nesjavellir Geothermal Power Plants and their maximum permissible concentrations (mg/kg) for potable water. When the chemical content of separated water is compared to potable water standards, one can see that in separated water from the Hellisheidi Geothermal Power Plant, the concentration of aluminium is about ten times higher and the concentration of sodium is about three times higher than permissible levels for potable water. The concentrations of sodium and fluoride in the separated water from Hellisheidi also exceed the limit and the concentration of aluminium is almost twice as high as the permissible level for potable water. In separated water from the Nesjavellir Geothermal Power Plant, the concentration of aluminium is about ten times higher, the concentration of potassium is almost three times higher than permissible levels for potable water. Iron content of condensate water from Nesjavellir also exceeds the limit. Concentrations of other chemicals in condensate and heated groundwater from both power plants is lower than the given limits for potable water.

| Chemical- and physiological factors | Unit | Max. recommended value for potable water | HELLISHEIDI | | | NESJAVELLIR | | |
|--------------------------------------|-------|--|-----------------|------------------|--------------------|-----------------|------------------|--------------------|
| | | | Separated water | Condensate water | Heated groundwater | Separated water | Condensate water | Heated groundwater |
| Acidity | pH | | 9.2 | 6.9 | 7.60 | 8.83 | 5.1 | 8.5 |
| T (pH) | °C | | 25 | 13 | 22.8 | 22.8 | 28 | 22.7 |
| Carbon dioxide (CO ₂) | mg/kg | * | 19.8 | 2.0 | 23.9 | | 20.9 | 40.7 |
| Hydrogen sulphide (H ₂ S) | mg/kg | * | 30 | 1.0 | 0.2 | 82.0 | 98.3 | 0.5 |
| Silica (SiO ₂) | mg/kg | * | 735 | <0.06 | 22.5 | 764.0 | 4.44 | 42.21 |
| Sodium (Na) | mg/kg | 200 | 206.0 | <0.1 | 6.97 | 159.0 | 1.78 | 21.0 |
| Potassium (K) | mg/kg | 12 | 35.5 | <0.4 | 0.98 | 31.6 | 0.3 | 2.69 |
| Calcium (Ca) | mg/kg | 100 | 0.78 | <0.1 | 4.88 | 0.27 | 0.86 | 8.91 |
| Magnesium (Mg) | mg/kg | 50 | <0.05 | <0.09 | 2.72 | 0.01 | 0.4 | 4.4 |
| Iron (Fe) | mg/kg | 0.2 | 0.0 | 0.01 | 0.01 | 0.03 | 0.29 | 0.01 |
| Aluminium (Al) | mg/kg | 0.2 | 1.90 | 0.39 | 0.004 | 1.99 | 0.02 | 0.076 |
| Sulphate (SO ₄) | mg/kg | 200 | 24.4 | 1.0 | 3.01 | 18.10 | 3.91 | 17.60 |
| Chloride (Cl) | mg/kg | * | 186.0 | 0.10 | 6.76 | 118.0 | 1.0 | 16.80 |
| Fluoride (F) | mg/kg | 1.5 | 1.52 | <0.005 | 0.09 | 0.90 | 0.01 | 0.16 |

*Maximum limits not specified in the potable water regulation