Electricity from Waste Heat – Distribution of Expertise

To talk about production of electricity from hot water might sound peculiar, but it is nevertheless, a realistic possibility. It might be even more peculiar to talk about export of such knowledge from Iceland. However, this possibility is within reach for us Icelanders. Our unique situation comes as a result of decades of experience in utilizing geothermal heat and the fact that we are the first in the world in using a particular technology.

The possibility came to us in connection to a renovation of a geothermal power plant in a small fishing town at Husavik, Iceland. The 2 MW_e "Kalina" electrical power plant was built, which uses 124° C hot water for generating electricity before the water is used for heating the town. The power plant in Husavik was put to work in July 2000 and is the first "Kalina" electrical power plant in the world that uses geothermal heat from a low-heat area for generating electricity. As a result, the particular project has given us a unique experience.

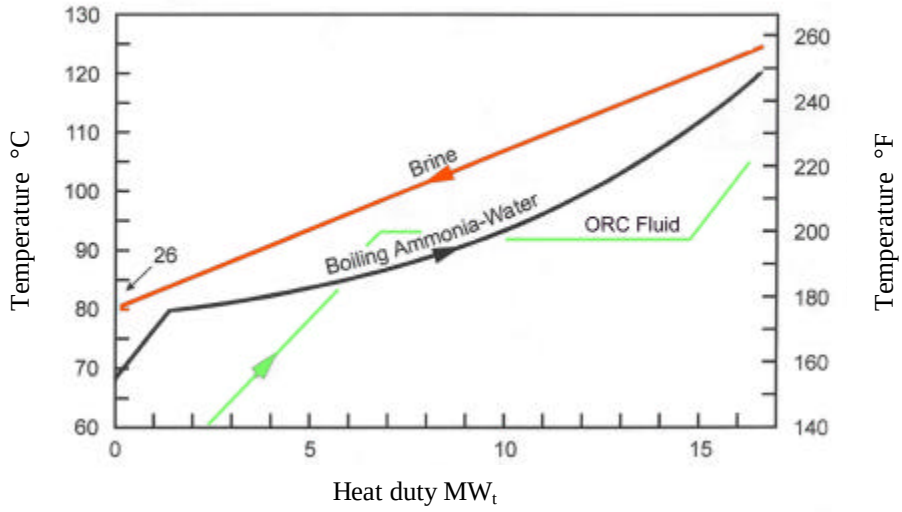
In continuation, the company X-Orka (X-Energy) was founded by the consulting and engineering companies VGK Ltd. Utras Ltd. and Tæknithing Ltd. along with Orkuveita Husavikur (Husavik Power Plant). The objective of the company is to develop and market electrical power plants that use heat from a low-heat source to produce electricity by using "Kalina" technology. Thus, the power plants will be used to generate electricity from low-heat geothermal areas, as well as being sold to industrial- and production companies for generating electricity from waste-heat. X-Orka will market the plants on an international basis, as a result of having secured the exclusive rights to the "Kalina" technology in Europe.

The Kalina Technology

The method is built on generating electricity by using heat-energy from a low-heat source in order to vaporise a mixture of ammonia and water, running in a closed circuit. It is precisely this mixture that makes this technology exceptional. The technique is named after Dr. Alexander Kalina, who is a Russian living in the USA. The "Kalina" technology has been developed over a two decades, however the commercial marketing of the technique started only a few years ago.

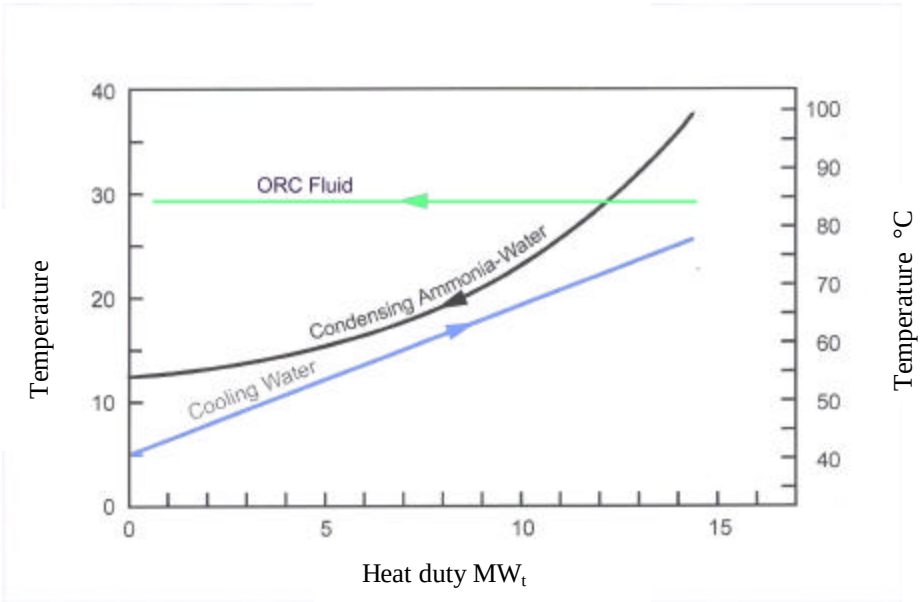
It is widely known that ammonia and water, as well as other single-component media, vaporises and condenses at a stable temperature. But the uniqueness of the "Kalina" technology comes from that the mixture vaporises and condenses at varying temperatures (see pictures 1 and 2). This give a possibility to utilize the waste-heat more effectively than with single-component media. Comparing of low-heat circuits demonstrates that by using the "Kalina" technology, the effectiveness of the electrical plants can be increased by 20 – 50 %. The superiority of the "Kalina" technology regarding effectiveness and cost was demonstrated and undisputed last winter, in a M.Sc. project of Mr. Geir Thorolfsson, an engineering student at University of Iceland.

The picture below (picture 1) shows a comparison between the vaporising process of an ammonia-water mixture in "Kalina" work-circuit and the vaporising process of a single-component media in "ORC" work-circuit. The vaporising-energy is transferred to the work-circuit by cooling hot water from 124° C to 80° C.



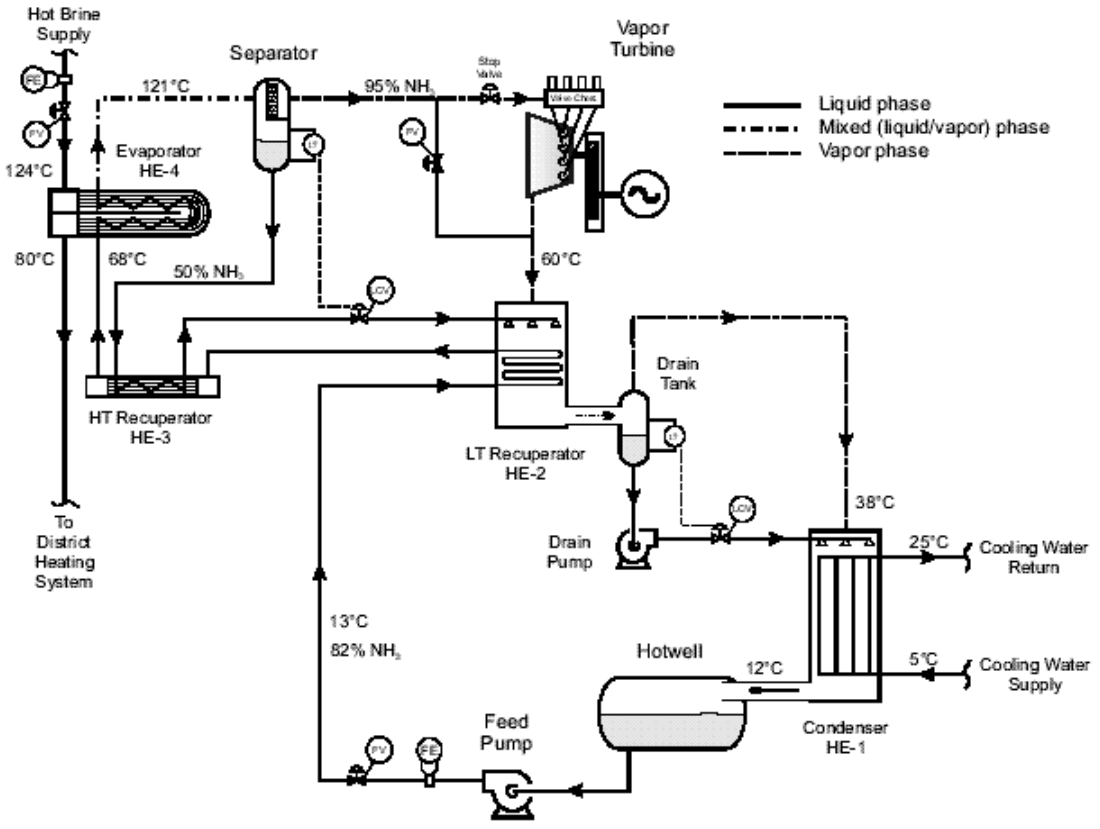
Picture 1. The vaporise process of ammonia-water mixture (Kalina) and of a single-component media (ORC).

The picture below (picture 2) shows a comparison between the condensing process of an ammonia-water mixture in "Kalina" work-circuit and condensing process of a single-component media in "ORC" work-circuit. The condensing-energy is extracted from the work-circuit by heating cold water from 5° C to 25° C.



Picture 2. The condense process of ammonia-water mixture (Kalina) and of a single-component media (ORC).

The picture below (picture 3) shows work-circuit for a 2 MW_e "Kalina" electrical power plant, the same as the plant in Husavik. The ammonia-water mixture is vaporised with geothermal water, which is cooled from 124°C to 80°C and the mixture's steam, powers a steam turbine, which rotates an electrical generator, which generate the electricity. The geothermal water from the plant is then used for heating the town. After the steam turbine, the ammonia-water mixture is condensed with fresh water, which is heated from 5°C to 25°C. The plant's cooling water is then used for a fish farming.



Picture 3. Work-circuit for 2 MW_e "Kalina" electrical power plant.

The Kalina Electrical Power Plant in Husavik

The low-heat energy plant in Husavik is the first geothermal power plant in the world, which use the "Kalina" technology for electrical production. The plant is generating approximately 2 MW_e of electricity by cooling 124°C hot geothermal water to 80°C, before the water is used to heat the town. The power plant in Husavik fulfils approximately 75% of the town's electricity demands.

"Orkuveita Husavikur" asked for proposals internationally, concerning solutions and equipment for the electrical power plant in Husavik and it turned out that the "Kalina" technology was the most cost-effective of the received offers. When comparing the offers, the price of the equipments and the effectiveness of the technology were looked at, as well as the environmental impact.

The low-heat power plant was put to work in July 2000 and has now been running nearly two years. The "Kalina" technology has proven its value in Husavik and the power plant has been running smoothly, except for some small problem in the beginning. The problem was traced to the design and manufacturing of the power plant separator and the condensers. The separator equipment has now been restored and the plant is running with full effectiveness.

Picture 4. The new "Kalina" low-heat power plant in Husavik.

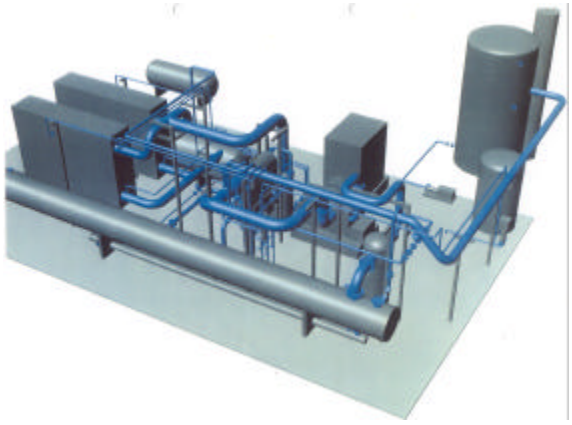
Marketing Opportunities

Low-heat can be found widely for the extraction of electricity by using a "Kalina" power plant. The heat can both be geothermal heat or waste-heat, such as exhaust from melting furnaces and diesel engines or cooling water from plants and factories that has turned hot. Waste-heat is often released into the environment, but often it has to be cooled before that. This is the case regarding thermal-, coal-, or diesel power plants as well as industries and factories using furnaces such as chemical companies, stone- and metal factories and municipal waste combustion. In the above incidences, waste-heat can often be used effectively by the "Kalina" technology. These companies are found all over the world.

It is foreseen that the price of the electricity generated by recycling a waste-heat is not competitive with the price of the electricity generated by the big, conventional power plants. However, demands on companies all over the world are increasing regarding optimal energy usage and minimising the environmental impact. To follow this up, energy taxes are used and grants are given to companies that improve their energy usage. On governmental level energy savings and regeneration have a granting priorities and the price for regenerated electricity can be higher than the price for the electricity in general. Moreover, the electrical market is opening up internationally, which gives more opportunities for the companies.

The goals of X-Orka are to develop and manufacture standardized "Kalina" electrical power plants, which are suitable for generating electricity from a geothermal low-heat as well as a waste-heat from industries and factories. The electrical power plants will be designed considering the specific requirements of the buyers. Equipment such as steam turbines, condensers and heat exchangers will optimised with the objective to reach a maximum effectiveness in each case. The plants will be constructed and fitted in container modules for enabling easy transportation and erection at site.

X-Orka has already secured the exclusive rights for selling the "Kalina" technology in Europe and will put emphasis on marketing the power plants in Iceland, Scandinavia and Western Europe. The company has already connection to parties in Denmark, Norway, UK, Germany and the Netherlands, which have shown interest in this unique technology.



Picture 5. 3D drawing of a 2 MW_e "Kalina" electrical power plant.