EXPLOITATION OF AN EXISTING GEOTHERMAL WELL FOR FISHFARMING OF STURGEONS

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ABSTRACT

This plant has been supported three times by the European Commission, (DG **XVII)** in 1981, 1989 and 1991. The aim of the project was the recovery of an old oil wildcat well to produce geothermal water to ensure the heat requirements for 5 hectares of greenhouses. Finally the plant was constructed in 1993 and hot water only used for fishfarming applications. The existing geothermal plant produces 200 m^3/h at 75°C temperature to maintain by means of a plate heat exchanger a temperature of 17°C in the ponds during all the year. The first year of exploitation (1992-1993) has a proved energy savings estimated at about **4 000** TOE.

The fist aim of the project in 1981 was to heat greenhouses with low enthalpy geothermal water and to recover an oil well (Mios 2, drilled down to 3,700 m) in the Bassin d'Arcachon, to tap the Upper Jurassic Mano Dolomite between 1,780 and 1,835 m. Depending on the results obtained, it was planned to test also the Purbeckian-Wealdian sandstones of the Lower Cretaceous formations between 1,701 and 1,759 m. Estimated primary energy saving from the project was 2,955 TOE/y with a corresponding payback of 2.5 years.

The contractor was the District d'Arcachon formed by the municipalities of Gujan-Mestras, Le Teich, La Teste and Arcachon.

After cleaning of the well down to 1,990 depth, the well was tested from May 1983 to January 1984. Perforations were carried out in the casing at 1,731- 1,793m/1,778 - 1,782m and 1,850- 1,859 m in the productive sandstone of Purbeckien-Wealdien and the Mano dolomite (Portlandien). The artesian production was 100 m^3/h and the reservoir transmissivity 180 darcy-meters.

A new set of perforations were made between 1,734 and 1,743 m, to optimize the well productivity and the definitive results were :

- Artesian production	160 m^3/h
- Salinity (equivalent Nacl)	3,7 g/l
- Temperature of geothermal water at well head	74°C
- Transmissivity	290 Darcy-meters
- High content of H_2S	

No reinjection well was planned because the nearby Ocean will not be polluted by a geothermal water at less than 5 g/l of total dissolved salt mainly Nacl. The aim was to heat greenhouses in the 3540°C range using heat pipes backed up by propane gas.

In spite of this excellent characteristics which were better than expected and allowing an instantaneous thermal power of about 10 MWt assuming a 20°C temperature for the discharge, the project was stopped because there were no horticultural candidates to use the heat at the surface.

In 1989, a new project was established by the District d'Arcachon in cooperation with the **DDAF** of Gironde (Ministry of Agriculture) to build a fishfarm to reach an annual production of 20 tonnes of sturgeons and 10 T. of eels.

To attain this objective of 30 T of fish production per year, a flowrate of 200 m^3/h at 75°C was absolutely necessary.

Consequently, a new stimulation of the reservoir was decided to produce 200 m^3/h without pumping equipment.

This operation (contract GE - 47/89/FR) was realized in 1989 to :

- install a well head with all the control and measuring systems necessary to carry out long term pumping tests,
- to perforate additionnal zones (486 holes) in order to increase the flowrate from the sandstones aquifer (1,700 - 1,730/1,753 - 1,755) and from the dolomite reservoir (1,763 - 1,765/1,798 - 1800/1,814-1,815/1,829 - 1,830)(Figure 1 - Technical section of the well).

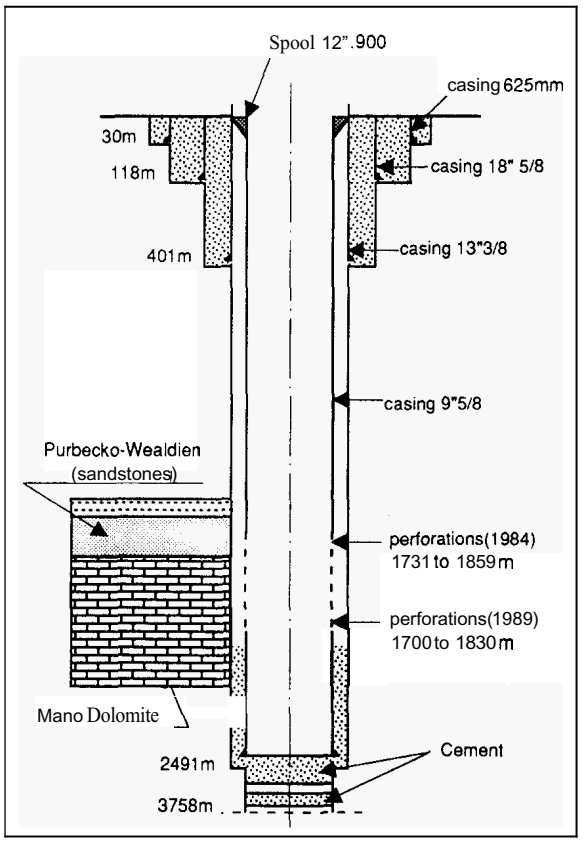

Fig. 1 : TECHNICAL SECTION OF THE WELL

This attempt was successful and the tests proved a productivity equal to that measured in 1984 taking into account the pressure losses in the well.

The final results indicated an artesian flowrate of 120 m^3/h at 74,2°C.

The pressure loss of the reservoir (3 bars in 5 years) was studied during the long term test and the final report gave the interpretation of the aquifer : static pressure of 172,6 Kg/m^2 at 1,705 m, Transmissivity 279 Darcy-m, Skin factor +14,6.

This last factor appears very high in relation to the production by means of perforations and the small thickness of the productive levels (23 m).
Reservoir simulation results shows a possible 30 years of exploitation period with a 200 m^3/h pumping rate and an admissible drawdown for the submerged elecmcal pump unit.

The geothermal loop was built in summer 1992 and comprises (figure **2**) :

- elecmcal submerged pump
- a variable speed control
- an exhaust tubing to produce the water
- a well head
- a surface network to carry geothermal water to the fishfarm (600 m)
- Monitoring equipments
- Plate heat exchanger of titanium in order to avoid corrosion and scaling.

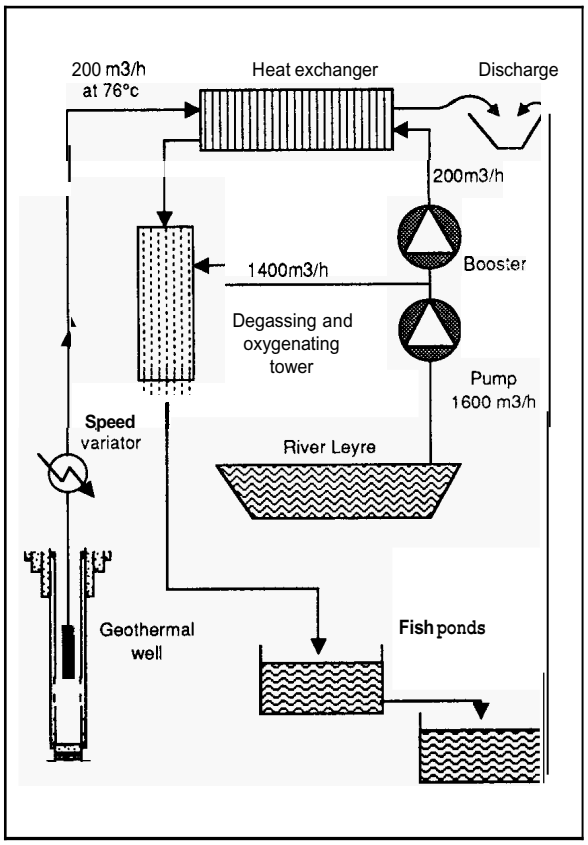

Fig. **2** : **GEOTHERMAL LOOP**

Fishfarm project description

The owner of the plant, Mister Zinzius, Director of "L'Esturgeonnière" worked during 4 years to finalize the project execution. He was helped by CEMAGREF (Centre d'Etudes de Machinisme Agricole du Génie Rural des Eaux et Forêts), and DDAF de la Gironde.

At the beginning, the project was based on an eel fishfarm, but at the end, sturgeon species was choosen due to the vicinity of the "écloserie" of Gironde which grow sturgeon larva.

The technical problems solved by DDAF were linked to the size of the fishfarm (80 tonnes of fish/years) but also in correlation with river "La Leyre" which deliver the cold water. The flow can vary from 4,5 m^3/h to 120 m^3/h and the difference of level can reach 2,,5 m in a flat zone occupied by swamps.
The pumping rate in the river can reach 1.200 m^3/h and only 200 m^3/h are heated by the plate heat exchanger used at equal flow. The temperature reached in the ponds is 17°C during all the year.

The fisfarm is composed of a pumping station in the river. (Hydromobil Ceven Group) which can pump in a very shallow water depth, with a pump speed of 0.15 m/s preventing the river water destruction of fries. The direct filtration at 2 mm and automatic washing of organic components is realized by water and air if necessary.

The water coming from the river *(85%)* is then degassed and oxygenated. Fifteen percent of the water goes directly to the plate exchange to be heated to more than 70°C. Then the total flow is treated in a degassing oxygenating tower before being pumped to the ponds.

The ponds are "raceways" built in concrete, six basins for fries of 36 m^2, ten basins for the fishfarm itself (180 m^2) and five last basins at the end of the circuit separated from the other by a secondary oxygenation device (air or liquid oxygen).

In case of acccidental pollution of the river, the oxygenation device allows a 24 hours running period without troubles for the fish. A monitoring system has been installed to control and regulate all the main parameters in the fishfarm (pumping rates, pH, temperature, oxygenation etc...).

Technical results of the demonstration phase

The geothermal exploitation started in August 1992 to test the plant at full scale. Some troubles and adjustments have to be mentioned :

- pressure regulation modifications
- problems linked to the transformer which has been replaced twice by the manufacturer
- resolution of gas bubbles in the network between the well head and the plate heat exchanger
- monitoring problems especially for temperature gauges
- plugging of the plate heat exchanger with leaves, minerals and organic elements coming from the river (an additionnal filtration device has been set up to overcome this problem).
- testing and experimentation of the growing cycles for sturgeons (2 or 3 kgs) at the commercial size.

The fust exploitation year can be considered as successful1 with regard to the plant size.

Energy aspects

Table 1 summarizes the exploitation data during the heating season 1992-1993. **A** net energy saving of 2.864 TOE has been measured and the extrapolation to a full year of production give an expected result of 4.000 TOE. This value can be compared with the design study carried out in 1990 and which forecasted possible savings of 3.248 TOE/y. This result was not only attained but was 20 % higher.

The heating capacity of the geothermal well is sufficient to ensure 100% of the heating requirements of the plant. No backup and no conventional energy boilers are necessary. If the pumping equipment breaks down, the owner of the fisfarm has on site a new pump and the removal and reinstallation of the pumping device needs 2 days which is acceptable for the fishs in the pond.

Economical aspects

The cumulative investments realized for the geothermal production is between 8 and 9 millions FF and has been done by the District d'Arcachon.

The exploitation costs are :

- electricity consumption evaluated at 405.000 F.F./y. The follow up and maintenance of equipment of the geothermal loop and network is 5G.000 FF/y and the heavy maintenance estimated at 120.000 FF/year.

Based on those assumptions and the real net savings of the 92-93 heating season, the pay back is about 3,7 years.

Table 1 : GEOTHERMAL PLANT OF "LE TEICH" (Season 92 - 93)

Months	Working days	Temp of river	Temp after heat exchanger	Flowrate of river (m^3/h)	Flowrate of the well (m^3/h)	ΔT (°C)	Power in th.	Energy produced per month
December	29	9,1	16,1	1.110	127	7	7.770	6.273
January	31	7,6	15,7	989	144	8,1	8.011	6.913
February	28	6,9	15,9	987	180	9	8.883	6.924
March	31	9,0	16,5	1.047	146	7,5	7.853	6.777
April	30	11,8	17,3	1.123	108	5,5	6.176	5.158
May	30	15.1	16.5	1.103	78	1,4	1.544	1.289
June	11	16.6	17.1	1.161	35	0.5	581	178

Total production of heat from December to June is 33 512MWt representing 2864 TOE. In that conditions and assuming a one year operation, energy savings will be annually 4000 TOE.

Conclusions

This demonstration plant is technically successful and the energy impact of 4.000 TOE/y of natural gas saved represents a big reduction of CO2 emission in this area close to the bassin d'Arcachon and Dune du Pilat.

The fishfarm is also successfull, the sturgeons are produced as expected, but the exploitationphase is to short for the moment to be sure of the economical rentability of the fishfarm which is very sensitive to the price of the sturgeons on the European market.

The operation itself is successful because itsldemonstrates the technical and financial feasibility.

The District d'Arcachon, a public authority formed by the municipalities of Arcachon, La Teste, Gujan-Mestras and Le Teich has acted as the investor for the geothermal part of the project which was risky and also for the local infrastructures (roads, access, land concession, ect.....). The district whose aim is not to be a geothermal operator rents the installation to the Société SA Esturgeonnière which has invested by itself the fishfarm installation.

This operation appear well adapted to utilize local energy resources and should be replicated. The limiting factor in this type of project is to find the good candidate to invest in a new industrial activity.
The failure of the first project (greenhouses) is a significant example of this problem but the success of the fishfarm proves also that the obstination of the public authority in the geothermal sector is necessary to overcome all the difficulties linked to renewable energy development.