

INSTALLED THERMAL CAPACITY AND THERMAL ENERGY USED OF
DIRECT USES OF GEOTHERMAL ENERGY IN JAPAN

Mitsuru Sekioka

Department of Geoscience, The National Defense Academy, Yokosuka, 239 Japan

Abstract

The aim of this summary is to analyze the status of direct uses of geothermal energy in Japan for space heating of houses and greenhouses, domestic hot water supply, fish breeding farm heating and snow melting, by combining the inlet temperature and the flow rate of each installation. Then, the total installed thermal power of 165 MWt and the total thermal energy used of 100 MWt are estimated. They result in the average load factor of 60%. The rate of oil saved by geothermal direct uses is also evaluated 0.04%.

1. Introduction

In Japan, geothermal energy is directly used in a number of sites not only in Hokkaido and Tohoku, both the cold regions where demand for heat is strong, but also in Kyushu, the mild region but blessed with thermal springs, for such purposes as elevation of agri- and aqua-cultural productivity as well as value-added of the products by heating.

So far several aspects of the direct uses of geothermal energy in Japan have been reported in Geothermal Resources Council, TRANSACTIONS as follows:

- (1) The snow melting systems (Sekioka et al., 3, 639-642, 1979),
- (2) The large-scale national projects (Sekioka and Fujitomi, 5, 567-569, 1981),
- (3) The leading installations of each application (Sekioka, 8, 163-167, 1984), and
- (4) An statistical analysis of inlet temperatures, flow rates and load factors (Sekioka, 10, 39-42, 1986).

In order to provide further information of each direct use application in Japan, statistical analysis has been carried out in succession to the report of 1986.

2. Combination of inlet temperature and flow rate

Taking the inlet temperature linearly on the ordinate and the flow rate logarithmically on the abscissa, the both parameters of direct uses are composed for space heating, agriculture, aquaculture and snow melting as shown in Fig.1. The numeral in each block indicates the number of installations. Classifying the inlet temperature below 40°C with l, between 40.1 and 60°C with m and above 60.1°C with h, while the flow rate below 50 l/min with L, between 50.1 and 500 l/min with M and above 500.1 l/min with H, we can characterize each application as follows:

- (1) In space heating and hot domestic water supply, the primary is mM followed by mL and hM.
- (2) In agriculture, the primary is also mM, followed by hM and lL.
- (3) In aquaculture, the primary is lH, followed by lM and mM.
- (4) Snow melting is divided into the two groups, mM for buried pipe systems and lH for sprinkling systems.
- and
- (5) In the whole application including additionally industries and animal husbandries, the primary is mM, followed by lH, hM and lM.

3. Thermal power and thermal energy

The total installed thermal power and the total thermal energy used are estimated for each application and prefecture to express in Tables 1 and 2 with the grand totals of 165 MWt and 100 MWt, respectively. Then, the average load factor is 60%. The rate of oil saved with geothermal direct uses is also evaluated 0.04% in all.

Fig.1. Composition chart of the inlet temperature and the flow rate for several direct use applications. Numerals in each grid indicate the number of installations. A: Space heating and hot domestic water supply, B: Agriculture, C: Aquaculture, D: Snow melting and E: The whole.

Fig.1 (A)

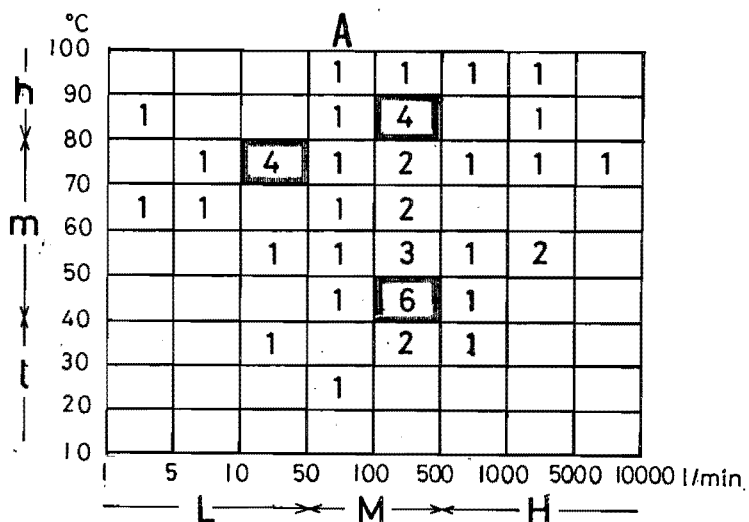


Table 1. Installed Thermal Power of Direct Uses of Geothermal Energy in Japan (April, 1988).

	* I Pref.	I Space heating I Mwt	Agri-culture Mwt	Aqua-culture Mwt	Snow melting Mwt	Pool Mwt	Industry Mwt	Stock breeding I Mwt	I Total I Mwt
HK	I	9.47	18.01	0.92	3.81	0.65	0.45		I 33.31
AO	I	0.73	0.12	0.03	1.40				I 2.28
IW	I		3.22						I 3.22
MY	I	0.19	1.65	0.03	0.74				I 2.61
AK	I	0.85	7.19	1.21	1.18	0.52	0.82		I 11.77
YT	I	0.08	0.00	3.29	1.81				I 5.18
FS	I					1.95			I 1.95
GM	I	9.69			1.81	0.39			I 11.89
TG	I	0.09	0.05		0.05				I 0.19
NN	I	1.85	0.40		1.14	0.01			I 3.40
SZ	I	0.86	1.27	3.58				0.10	I 5.81
GF	I	21.12		0.40	1.01	0.21			I 22.74
HY	I					0.09			I 0.09
WK	I			0.17					I 0.17
OK	I	0.12	0.02						I 0.14
SN	I			0.01	0.35				I 0.36
YG	I		0.20						I 0.20
SG	I		0.01						I 0.01
KM	I	0.96	0.93	1.06					I 2.95
OI	I	5.54	20.52	4.24					I 30.30
KG	I	3.45	8.24	12.92		0.08	0.02	0.10	I 24.81
Total	I	55.00	61.83	27.86	13.30	3.90	1.29	0.20	I 163.38

*) Abbreviation of the name of Prefectures is refer to Table 2.

Fig.1 (B)

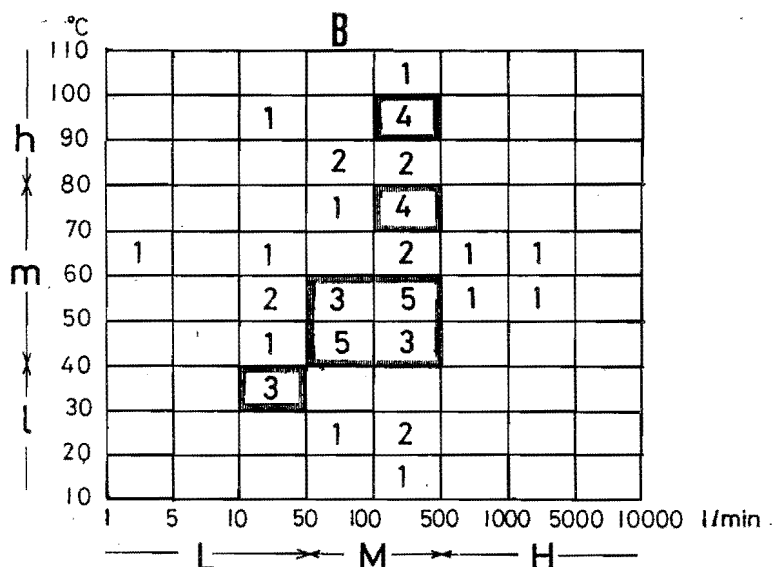


Table 2. Thermal Energy Used of Direct Uses of Geothermal Energy in Japan (April, 1988).

	* I	Space heating	Agri-culture	Aqua-culture	Snow melting	Pool	Industry	Stock breeding	I Total
Pref.	I	MWt	MWt	MWt	MWt	MWt	MWt	MWt	I MWt
HK	I	6.91	11.79	0.92	1.34	0.55	0.23		I 21.74
AO	I	0.37	0.05	0.03	0.70				I 1.15
IW	I		1.15						I 1.43
MY	I	0.13	1.43	0.03	0.20				I 1.51
AK	I	0.44	3.51	1.21	0.33	0.26	0.47		I 6.22
YT	I	0.04	0.00	3.29	0.50				I 3.83
FS	I					1.95			I 1.95
GM	I	3.00			0.65	0.20			I 3.85
TG	I	0.03	0.03		0.02				I 0.08
NN	I	0.98	0.21		0.31	0.00			I 1.50
SZ	I	0.39	0.66	2.69				0.04	I 3.78
GF	I	11.09		0.40	0.33	0.04			I 11.86
HY	I					0.01			I 0.01
WK	I			0.07					I 0.07
OK	I	0.07	0.01						I 0.08
SN	I			0.01	0.09				I 0.10
YG	I		0.05						I 0.05
SG	I		0.00						I 0.00
KM	I	0.38	0.48	1.06					I 1.92
OI	I	4.17	14.22	4.24					I 22.63
KG	I	3.34	3.73	7.65		0.08	0.01	0.03	I 14.84
Total	I	31.34	37.32	21.60	4.47	3.09	0.71	0.07	I 98.60
Load Factor	I	57%	60%	78%	34%	79%	55%	35%	I Mean 60%

*) Abbreviation of the name of Prefectures is as follows: HK=Hokkaido, AO=Aomori, IW=Iwate, MY=Miyagi, AK=Akita, YT=Yamagata, FS=Fukushima, GM=Gumma, TG=Tochigi, NN=Nagano, SZ=Sizuoka, GF=Gifu, HY=Hyogo, WK=Wakayama, OK=Okayama, SN=Shimane, YG=Yamaguchi, SG=Saga, KM=Kumamoto, OI=Oita and KG=Kagoshima.

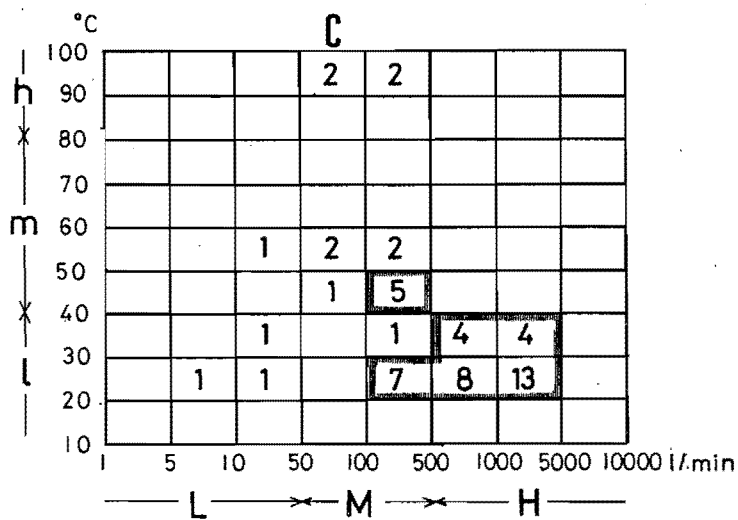


Fig. 1 (D)

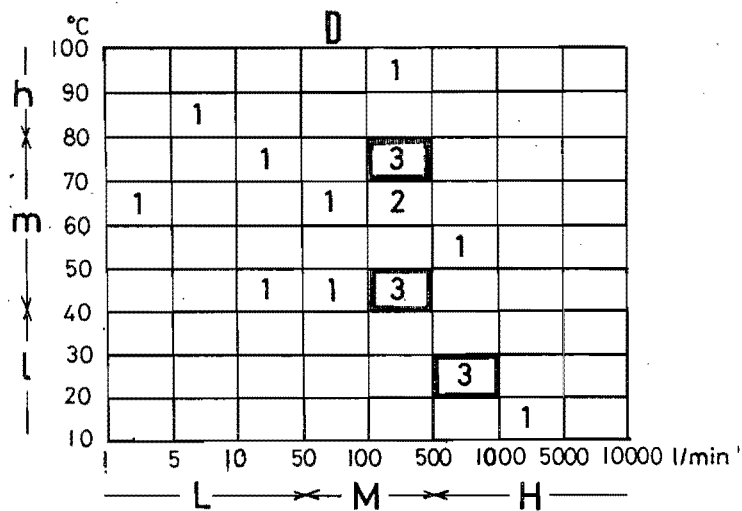


Fig. 1 (E)

