Key Issue:
15-Other

Climate Zone:
Cf: Temperate humid climate

Subject:
- Processing and Effective Use of Driftwood in the Reservoir

Effects:
- Effective Use of Construction Byproducts

Entire View of the Taki Power Plant and the Taki Dam

Project Name: Taki Dam
Country: Fukushima Pref., Japan (Asia)

Implementing Party & Period
- Project: Electric Power Development Co. Ltd. (J-POWER)
1961 (Commencement of operation) -
- Good Practice: Electric Power Development Co. Ltd. (J-POWER)
1990 -

Keywords:
Driftwood, Recycling, Charring

Abstract:
Taki Dam is located in an area of heavy snowfall, and a large amount of driftwood flows into the reservoir annually during periods of high run-off due to thaw and rainfall. The removal of this driftwood requires much labor and cost. Moreover, its final disposal often encounters problems. As a result, studies were carried out on the beneficial use of driftwood, and technologies were developed for its recycling into charcoal, wood vinegar and craftwork. In 1993, this Good Practice was commended by the Ministry of International Trade and Industry for its contribution to the promotion of waste recycling.

1. Outline of the Project

The Taki Dam in the Tadami River, which belongs to the Agano River system, is located in Kanayama-machi, Oonuma-gun, Fukushima Prefecture. This gravity overflow concrete dam, exclusively used for power generation, has a 264 m long crest, 46 m elevation, effective storage of 10,300,000 m^3 and catchment area of 1978.8 km^2.

With the attraction of the rich hydropower resource of the Tadami River that runs through the project site, the investigation of the midstream and upstream of the river started long time back in the end of the Taisho Period (1912 to 1926), along with the development of the main Agano River in the downstream. With a rapid rise in electric power demand after WWII, the development of the midstream area progressed concurrently with a second investigation of the entire watershed. This led to the consistently planned development of the Tadami River System, with a goal of constructing facilities with a generating capacity of 2,000 MW. The plan included the construction of large upstream reservoirs in Okutadami and Tagokura and a group of midstream balancing reservoirs. Later on, the 10^{th} meeting of the Adjustment Council of Electric Power Development Co. Ltd. in July 1953 agreed on the general development plan for the Tadami and the Kuromata River and reached the decision to construct the Taki Power Plant as the afterbay reservoir of the Tagokura Power Plant.

The construction, preceded by the investigation and survey of the power plant site in 1958, started in July 1959. In July 1961, the reservoirs were filled and on August 15 of the same year, power generation started. Table 1 shows the specifications of the Taki Power Plant and the Taki Dam.

Table 1 Specifications of the Taki Power Plant and the Taki Dam

Item		Specification
Power Plant	Name	Taki Power Plant
	Source of water	Tadami River, which belongs to the Agano River system
	Maximum output	920,000 MW
	Maximum discharge	300 m^3/sec
	Effective head	35.82 m
	Number of generators	2
	Waterwheel type	Single vertical axis spiral Kaplan
Dam and Reservoir	Name	Taki Dam/Taki balancing reservoir
	Type	Concrete gravity
	Dam height	46 m
	Crest length	264 m
	Dam volume	120,343 m^3
	Catchment area	1978.8 km^2
	Total reservoir capacity	27,000,000 m^3
	Available depth	5.0 m

2. Features of the Project Area

The Tadami River, which runs through the Taki Dam point, originates in Lake Oze and flows into the Sea of Japan. The river, which runs a total distance of approx. 260 km and has a catchment area of approx. 8,400 km2, is blessed with a rich water resource thanks to heavy snowfall during the winter period and an available head of as high as 1,400 m, and has been a site for hydropower development since before the war. As the

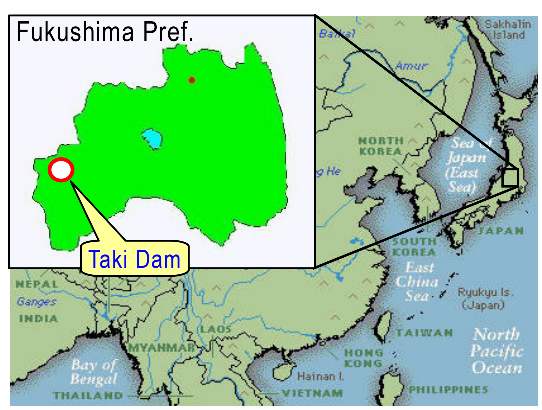

Fig. 1 Location Map of the Taki Dam

site is located in a narrow place between mountains in an area of high snowfall, a large amount of driftwood flows into balancing reservoirs whenever flooding occurs due to snow melting and rainfall, and therefore the removal of driftwood is an annual event.

3. Benefits

3.1 Background of Effective Use of Driftwood


Photo 1 Driftwood in the Dam Lake

Dam reservoirs have an inflow of a large amount of driftwood and other forms of debris during typhoons and heavy rainfalls (Photo 1). These driftwood and other forms of debris not only cause problems to water intake for power generation but also damage the landscape of dam reservoirs. It is, therefore, one of important hydropower maintenance responsibilities to routinely remove them from reservoirs for disposal. However, the removal requires large facilities and much labor and cost, and final disposal of removed driftwood and other forms of debris have often presented considerable problems. Although depending on the severity of floods that occur each year, the amount of driftwood and other forms of debris processed annually is an average of over 30,000 m^3, which, however, does not include the large amount of intact, submerged driftwood. This example shows a driftwood recycling effort, for example, by charring it, to ensure their effective use.

3.2 Recycling through Charring

Driftwood is so diverse in conditions, for example, regarding the tree type and age, length, thickness, shape (straight or curved), and degree of damage and staining. In consideration of these conditions, dam site conditions, characteristics of recycled products and social demand among other factors, Electric Power Development Co. Ltd. decided on an effort to recycle driftwood by charring it.
The advantages of carbonization worthy of note include:

1) Thermal decomposition of fur, staining, mold and other impurities produces stable carbides.
2) Since carbides are free of corrosion or chemical changes, they have no adverse effects on the environment when left unused.
3) Carbon fixation helps reduce carbon dioxide emissions from driftwood burning.
4) Since carbonization reduces the weight by about 20% and the volume by about 60%, transportation becomes easy.
5) Since the masses of charcoal can easily be crushed, this increases transportation options.
6) Carbonated materials have many applications including fuels and charcoals.

The charcoal manufacturing process is as shown in the flow chart in Fig. 2. Fig. 3 shows an example of the traditional Japanese charcoal kiln made of clay and rocks used as the test kiln around the Taki Dam. The charcoal manufacturing test succeeded for the first time in September 1990. The attempt was unprecedented in the world, and the product was called driftwood charcoal. About 2% of the several thousand cubic meters of driftwood removed each year is charred for their effective use.

1. Removal of driftwood from reservoirs
↓
2. Sorting of driftwood
↓
3. Storing and drying of driftwood
↓
4. Production of charcoal
↓
5. Vertical laying of driftwood in the kiln
↓
6. Increasing of kiln temperature
↓
7. Carbonization (Collection of wood vinegar)
↓
8. Refining
↓
9. Sealing and cooling of the kiln (Black charcoal)
↓
10. Opening of the kiln
↓
11. Processing and shipping

Charcoal manufacturing cycle (steps 5–10)

Fig. 2 Driftwood Charring Process

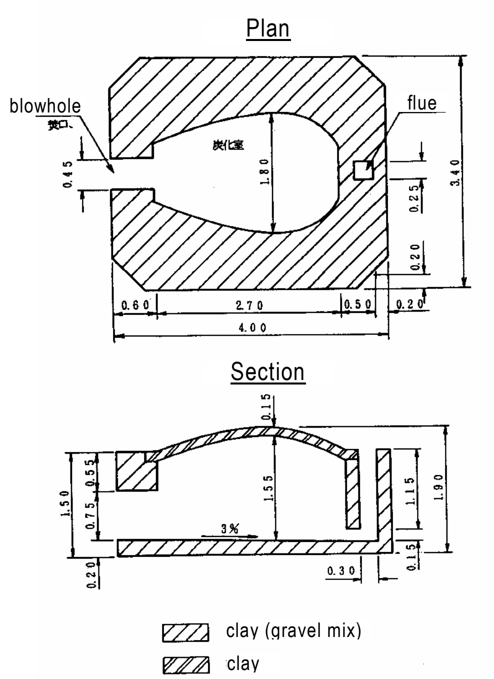

Fig. 3 Test Kiln for Driftwood

Table 2 shows a quality comparison between the driftwood charcoal and the charcoal manufactured from ordinary wood. The driftwood charcoal, characterized by such properties as a small ash content and a large calorific value, found an application as a clean fuel. Since it also has aerating, particle capturing, water cleaning, humidity control and deodorizing capacities associated with its porous surface, it is used in various products including humidity control construction materials (for example, sheets), water cleaners and pillow and mattress stuffing, which are commercially available through the affiliates of Electric Power Development Co. Ltd.

Table 2 Quality Comparison between Charcoal Manufactured from Ordinary Wood and Driftwood Charcoal

Item		Charcoal manufactured from ordinary wood (Japanese beech)	Driftwood charcoal (Japanese beech)
Calorific value (kcal/kg)		7.040	7.590
Ash content (%)		7.0	3.0
Elementary analysis	Carbon (%)	85.5	86.3
	Hydrogen (%)	1.2	2.2
	Nitrogen (%)	0.4	0.3
	Oxygen (%)	5.9	8.2
True specific gravity		1.76	1.55
Unit weight (g/cm^3)		0.57	0.37
Water absorption (%)		124	136
Hardness		12.0	3.0
Effluent pH		8.8	7.5

3.3Use of Wood Vinegar

Collecting and cooling the gases discharged from the smokestack during the charcoal manufacturing process produces condensed liquid with pungent smell. This liquid, which is thermally decomposed tree fibers of cellulose and lignin, is separated by gravity into three layers when left standing: the upper layer comprising lightweight crude oil, the intermediate layer comprising wood vinegar and the bottom layer comprising tar. The wood vinegar is strongly acid (pH2 to 3) transparent liquid with a yellowish or brownish tint, and contains acetic acid as the main component, and reportedly, over 200 types of other organic compounds. This wood vinegar, like charcoal, has proven to have a number of effects that reflect the working of natural chemical components, and thus has attracted increasing research interest. Wood vinegar is commercially available today for gardening applications and for applications similar to those of the driftwood charcoal.

3.4 Use of Driftwood in Craftwork

Driftwood has a corroded and softened surface thus giving the first glance impression of being rotten. However, it often has a solid interior. The interior of quality driftwood with attractive grain patterns is used to produce woodwork, which is sold at a shop in the dam.

3.5 Development of Skin Care Cosmetics

A method was developed to make more effective use of characteristics of wood vinegar that contains a wide variety of components. This method uses a special solvent to remove biologically hazardous substances, formaldehyde and methanol, from wood vinegar and produces refined high quality wood vinegar that contains plant polyphenol and essential unsaturated fatty acid. Since this refined wood vinegar has proven to have sterilizing, antioxidative, moisturizing and antiviral effects and proven to be safe for human use, its first application as a cosmetic ingredient in Japan was approved by the Ministry of Health and Welfare. Using the wood vinegar, a series of skin care cosmetics (cleansing cream, face washing foam, face lotion, milky lotion and mud facial pack), moisturizing cream for family use, and additionally, shampoo and hair treatment were developed, and are manufactured and marketed today. The refined wood vinegar contains, as the base component, catechins with excellent purifying and moisturizing effects, which help keep skin clean, clear and moist. These cosmetic effects of wood vinegar that derives from natural trees enjoy increasing popularity among people with dry skin problems.

4. Effects of the Benefits

The following results were achieved through the effort to effectively use driftwood.

1) The driftwood recycling technology was established.
2) The useful properties of the recycled products were identified.
3) There is a potential for growing demand for the recycled products.
4) The driftwood resource is available in large amount every year.

These efforts have paved the way for effective use of driftwood, which had been disposed of by burning or disposed of as industrial waste, to produce charcoal, wood vinegar, woodwork and other products. Since the problem of driftwood disposal is common to other dams, the knowledge acquired through these efforts can, hopefully, be applied to other dam sites.

5. Reasons for Success

1) The way was paved for effective use of driftwood, for which no effective applications had been found.
2) There is a possibility that the disposal cost previously required may be cut.
3) The raw material is readily available.

6. Outside Comments

Large amounts of driftwood flow into dams and electric power companies have large expenses for driftwood disposal. These efforts introduced successfully established the way to effectively use driftwood, which had had no satisfactory applications (May 1993 Issue of Clean Japan, Clean Japan Center).

7. Further Information

7.1 References

1) Shigenori Kuroda et al., "Disposal and Effective Use of Driftwood in Dam Reservoirs" Japan Electric Power Civil Engineering Association No. 254 Nov. 1994
2) Clean Japan Center "Recycling Idea Contest" Clean Japan Vol. 100 May. 1993
3) Electric Power Development Co. Ltd. Records of New Construction of Tagokura and Taki Power Plants in the Tadami River, which Belongs to the Agano River System Dec. 1966

7.2 Inquiries

Engineering Department,
Electric Power Development Co. Ltd. (J-POWER)
Tel: +81-3-3546-2211
Fax: +81-3-3546-9423