MEC

THERMAL SPRAY FACILITIES

COATING SYSTEMS FOR HVOF, PLASMA, FLAME SPRAY, ARC SPRAY & ROD SPRAY

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EROSION & CORROSION PREVENTIVE COATING ON HYDRO-TURBINE & OTHER PARTS

For a developing county like India the need of the hour is to generate Power. This would accelerate the rate of development. Simultaneously the search for clean power is a must and in this regard Hydro power is the one of the feasible option. However there is a still a lot of untapped Hydro power and technological limitation should not come in between for realizing this option and exploiting the same to the fullest.

A Hydro Power plant is a national asset and it is our duty to see that the components that are therein should last its design life. This necessitates us to look for the solutions. The major problem faced by this industry is that off corrosion and wear.

The problem of erosion is perpetuated due to silt in India and has been found to be quite serious in a number of hydropower stations, especially in those located in the Himalayan region. This problem is aggravated due to increased silt size and content and is responsible for quick erosion and corrosion. Some of the power stations affected by silt-erosion damage in India are given in Table 1

The components prone to erosion of these power stations are categorized for low and high particle impact energy. Since hydro-abrasion is a function of many different parameters such as sand-particle size, hardness, concentration, quantity, shape and velocity, in most cases, this is minimized by controlling these parameters.

The size of the particles is generally restricted to 250 µm and velocity below 75 m/s to have proper control on high-energy impact wear. In spite of this, significant surface damages to hydroelectric machines and structures occur, thereby causing scratching and material removal. The surfaces exposed to abrasion are divided into two main categories viz., low energy impact, such as profile portion of guide vanes and high-energy impact, such as runner, labyrinth & guard rings. Most of these are made from corrosion-resistant martensitic stainless steel& areconsideredlessresistanttoabrasion.

Protection of these components with suitable coating is essential to minimise their damage due to abrasion. Hydro power stations in India facing regular damage due to excessive silt in water.Legendfortheextentofdamage.

A) Very severe; requires repair every two monsoons, particle impact energy >10µJ.

B) Severe; requires repairs every 3 - 4 monsoons, particle impact energy 510 µJ.

C) Considerable; requires repair every seven to eight monsoons, particle impact energy<5µJ

Project	State	Unit X Mw	Head (mm)	Speed (rpm)	Type of Turbine	Extent of damage
Baira Siul	H.P.	3x60	240	375	Francis	A
Maneri	U.P.	3x30	180	428.6	Francis	A
Jaldhaka	W.B.	3x9	148	600	Francis	A
Bhaba	H.P.	3X40	900	500	Pelton	A
Chilla	U.P.	4x36	32.5	187.5	Kaplan	B
Dehar	H.P.	6x165	282	300	Francis	B
Khatima	U.P.	2x13.8	18	166.7	Kaplan	B
Lagyap	Sikkim	2x6.3	530.5	1000	Pelton	B
Machkund	A.P.	4x17	245.4	600	Francis	B
Gamerbal	J&K	3x3	137	1600	Francis	B
Kosi	Bihar	4x4.8	6.1	93.8	Bulb	B
Perriyar	T.N.	4x35	374	750	Francis	B
N. Jhakri	H.P.	6x250	428	300	Francis	B
Salal	J&K	3x115	95	187.5	Francis	B
Shanan	Punjab	1x50	488	375	Pelton	B
Ghanvi	H.P.	1x11.6	374	600	Pelton	C
Chibro	U.P.	4x60	110	250	Francis	C
Pathri	U.P.	3x6.8	11i	136.3	Kaplan	C
Dhakrani	U.P.	3x11.2	19.8	187.5	Kaplan	C
Dhalipur	U.P.	3x17	30.5	150	Francis	C
UBDC	Punjab	3x15	17.1	150	Kaplan	C
Kundah-II	T.N.	5x35	713	428.6	Pelton	C
Kundah-III	T.N.	3x60	412	333.3	Pelton	C
Kundah-IV	T.N.	2x50	64	157.9	Francis	C
Umtru	Megha	4x2.8	53.3	500	Francis	C
Andanpur	Punjab	4x33	187.5	187.5	Kaplan	C

In recent years, with the development of thermal spraying technology and in particular High velocity oxy fuel (HVOF) system has revolutionized the coating industry. The coatings generated by this system are proven to be efficient against harsh environmental conditions.

Since the coatings show advantages in density and bond strength it makes it attractive for many wear and corrosion resistance applications. Its high coating quality results from the use of a hot combustion-driven high-speed gas jet for thermal spraying.

These coatings have environmental advantages compared to chemically/ electro-chemically formed coatings. **Fig 1** depicts one such coating process in progress wherein a hydro guide vane is being coated using HVOLF system using tungstencarbidealloy.

Fig 1 : Coating of Guide Vane and Pelton Wheel using HVOLF System & allied by Robotics for efficient coating processes.

Tungsten carbide powders are widely used in the HVOF spraying system. These are used to produce dense, high hardness and excellent wear resistance coatings generally to combat the erosion and corrosion occurring in hydro power plants and pumps. In applications where abrasive or erosive wear resistance is of primary importance, WCCo with and without nickel or chrome is used. However WCCoCr powders are preferred when high corrosion resistance is needed.

Further it is very important to be very careful in selecting appropriate coating system as well as correct composition of coating material. Improper selection again will lead to premature failure.

Fig 2 : Un-coated Hydro Turbine Component (Runner)

Fig 3 compares between two commonly used Tungsten carbide coatings while coating (1) has corroded while coating (2) containing Cr has not.

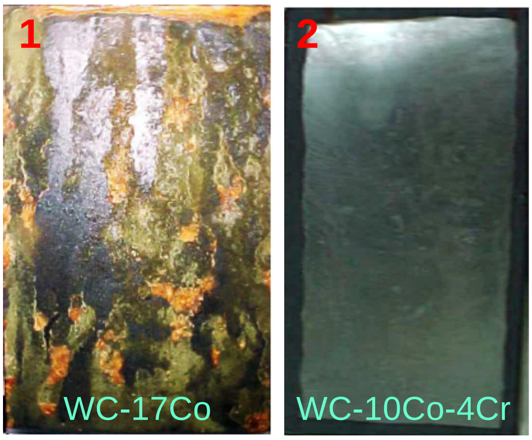

Fig 3 : Salt Spray Tests carried out on coatings

Hence it becomes very important to select a proper coating as the requirement changes with different types of wear as the mechanism of wear involved is different in each case. As an example erosive wear is caused by plastic deformation or brittle fracture, but both mechanisms can also operate simultaneously. Erosion of metals usually involves plastic flow and the predicted wear rate, W, is inversely proportional to H, the hardness of the surface. Hence a hard coating is preferred. While cavitation can be addressed by having a coating which is not only corrosion resistant but also pseudo elastic in nature. For these properties Nickel based Tungsten carbide coatings can be used.

Experiments carried by researchers have shown that Thermally sprayed Tungsten carbide with Nickel binder have reduced cavitation as well as slurry erosion and especially coatings done by High Velocity Oxy-Liquid Fuel (HVOLF) system have fared better. In general HVOLF coatings have improved the life of bare material as much as by 86-143 times.

PREVENTION OF CORROSION

In addition to the turbine machinery, prevention of corrosion in steel structure by atmospheric corrosion is also of very importance and they also need to be suitably coated as the stakes involved are very high. The thermal coating systems developed by us to coat Zinc and Aluminum have proven applications to combat this very problem. The dam depicted in Fig 4 is a testimony to that claim.

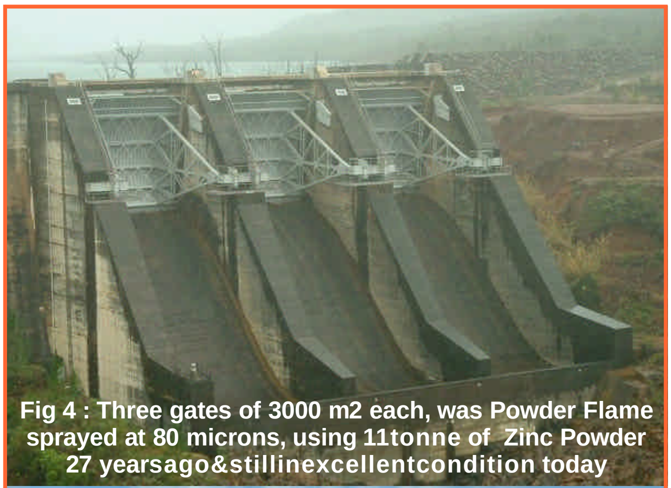

Fig 4 : Three gates of 3000 m2 each, was Powder Flame sprayed at 80 microns, using 11 tonne of Zinc Powder 27 years ago & still in excellent condition today

Fig 5 : A Rail Bridge protected by Zn-Al Coating

There are many different types of corrosion as well as many types of wear. Hydro industry is facing all of them. One of the viable and economic options is to thermally coat such components and improve the life, because it is our collective responsibility to protect our national assets.

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