Centrifugal Pump working as turbine in various water resources at Uttarakashi in Uttarakhand

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Abstract— Hydro power is a renewable energy resources.In the Himalayan State Hydro power is the main power generation because of availability of water in the various areas.Uttarakhand is one of the Himalayan State in India where various water resources are available.Large Hydro power are not easily constructed.Small and Micro Hydro power plant can easily constructed and are not effected environment.Centrigugal pump is one of the best replacement of Hydro Turbine in small and micro hydro power generation.In this paper centrifugal pump is used as a turbine in various water resources at Uttarakashi District in Uttarakhand in various water stream.

Keywords— Turbine,Hydro Power,Centrifugal Pump,Electricity,Rural,Small

1 Introduction

In the present scenario all world focusing for power generation by the non conventional and renewable energy resources. The conventional energy resources are producing more electricity in present scenario but this is very harmful and more effective to environment as a result of this global warming is the main issue in world wide.

Running pumps in reverse mode working as turbines is a concept that has been around for many years and proven to be cost-effective mainly in micro-hydro applications. This concept was first introduced for power recovery purposes in industry, which gave way to a rich era of research with experimental testing of pumps but operating in turbine mode. Work aided this new concept as it brought out information on pump performance under special operating conditions

Pump workimg in a turbine mode is the best mode for power generation in micro hydro power plant.Specially in uttarakhand where the stream of water resources are available in wide area in the various hill areas of the uttarakhand .Manr water resources are not useful and it contain more dischare throughout the year.so it is necessary to how to use these water stream for power generation.

The behaviour of the pump changed when it is working in a turbine mode. Small hydroelectric power stations became attractive for generating electrical energy after the oil crisis of the seventies. However cost per kW energy produced by these stations is higher than the hydroelectric power plants with large capacity. Numerous publications in recent years emphasize the importance of using simple turbine in order to reduce the cost of produced electrical energy.

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2 LITERATURE REVIEW

An experimental investigation of centrifugal pump has been carried out to study its characteristics in pump and turbine mode operation

By using the experimental results of tested pump and pumps of some previous researchers new correlation have been developed by using its best efficiency and specific speed in pump mode.

The concept of electricity generation through reverse running centrifugal pump is not new.Around 80 years ago the research on this field has been started .A large number of Theortical and experimental studies have been done for prediction of performance of reverse running centrifugal pump.But still there is a need to explore this area more deeply to harness the advantages of this technology for sustainable development.

Selection of a proper pump as turbine for a site is a big problem in installation of pump in small hydro site.Several researches viz. Stepanoff, Childs,Sharma, Wong Williams Alatoree –Frenk etc.presented some relation for predicting the performance od pump as turbine.These relations were based upon either pump efficiency or specific speed

The objective of these relations is to calculate the best efficiency point of pump for turbine mode by using the pump operation data provided by manufacturer. In 1962 childs presented the PAT prediction method based on the efficiency of pump.

Hancock stated that for most pumps the turbine BEP is lies within within 2% of the pump mode BEP.Also Grover and Herget proposed PAT prediction method based on specific speed for turbine mode specific speed range 10-50. Comparison between experimental results and methods proposed by the above researchers show relatively large devition therefore.the use of these formulate had been confined for approximate selection of PAT.

International Journal of Scientific & Engineering Research Volume 8, Issue 12, December-2017
ISSN 2229-5518

The Table represent the various scientist research on PAT and they give their criteria for selection of pump when working as turbine

S.No	Name of Investigator	Criteria	Head Ratio	Discharge Ratio	Remarks
1	Stepanoff	BEP	$1/\eta_p$	$1/(\eta_p)^{1/2}$	Accurate for Ns in the range of 40-60
2	Alatoree-Frenk	BEP	$1/(0.85\ \eta_p{}^{5}+0.385)$	$1/(0.85\ \eta_p{}^{5}+0.385)/2\ \eta_p{}^{9.5}+0.205$	-------------
3	Schmiedl	BEP	$-1.4+2.5/\eta_{hp}$	$-1.5+2.4/\eta_{hp}{}^2$	--------------
4	Grover	Specific Speed	$2.693-.0229N_{st}$	$2.379-.0264N_{st}$	Applied for Ns in the range of 10-50
5	Sharma	BEP	$1/(\eta_p)^{1.2}$	$1/(\eta_p)^{0.8}$	Applied for Ns in the range of 40-60
6	Hergt	Specific Speed	$1.3-6/N_{st}-3$	$1.3-1.6/N_{st}-5$	-----------------
7	Childs	BEP	$1/\eta_p$	$1/\eta_p$	------------------
8	Hancock	BEP	$1/\eta_t$	$1/\eta_t$	------------------

3. MATHEMATICAL ANALYSIS OF PAT

In this paper the mathematical analysis for selection of pump as turbine according to the scientist Schmiedl and Alatoree-Frenk. By suing their formulas the PAT will be selected for BEP

We have pump data in pump mode by various Manufacturer.

Pump Data in Pump Model (Kirloskar pump specification)

S.No	Hp	Qp(lps)	Np(rpm)	Nsp(rpm)	η_p %
1	14.5	10.8	1500	21.0	77.0
2	19.8	65.9	1450	39.7	85.0
3	10.6	103.	1450	79.1	84.0
4	21.5	26.5	1500	24.5	78.0
5	5.6	13.5	1450	46.4	76.0

We have pump dta in pump mode and now we will find out the pump specification in turbine mode by the mathematical calculation the formula provide by Schmiedl and Alatoree –Frenk

By the mathematical calculation on the formulas on Schmiedl and Alatoree-Frenk the turbine mode Best Efficiency Point is obtained.

Schmiedl Calculation Formulas

Head Ratio=H_t/H_p

Discharge Ratio=Q_t/Q_p

Head Ratio= $-1.4+2.5/\eta_{hp}$

DischargeRatio= $-1.5+2.4/\eta_{hp}{}^2$

According toSchmiedl pump specification in turbine mode

PUMP MODE BEP			TURBINE MODE BEP		
Hp(m)	Qp(lps)	η_p(%)	H_t(m)	Q_t(lps)	η_t %
14.5	10.6	77	26.77	27.5	73
19.8	65.9	85	30.51	120	82
10.6	103	84	16.70	195	79
21.5	26.5	78	38.99	64.78	77
5.6	13.5	76	18.42	35.84	73

Alatroee-Frenk Calculation Formulas

Head Ratio=H_t/H_p

Discharge Ratio=Q_t/Q_p

Head Ratio= $1/(0.85\ \eta_p{}^{5}+0.385)$

DischargeRatio= $1/(0.85\ \eta_p{}^{5}+0.385)/2\ \eta_p{}^{9.5}+0.205$

According to Alatoree-Frenk pump specification in turbine mode

PUMP MODE BEP			TURBINE MODE BEP		
Hp(m)	Qp(lps)	η_p(%)	H_t(m)	Q_t(lps)	η_t %
14.5	10.6	77	23.57	17.85	72
19.8	65.9	85	25.98	79.45	83
10.6	103	84	15.05	129.91	75
21.5	26.5	78	35.42	42.42	76.5
5.6	13.5	76	9.18	22.99	76

International Journal of Scientific & Engineering Research Volume 8, Issue 12, December-2017
ISSN 2229-5518

Result:
Schmiedl and Alatoree-Frenk gives the Best Efficieny point in their study. And using their formulas we can set a range for site selection of a PAT.
According to Both the scientist research calculation we can set a range as the table given below
For the best efficiency point the range of Head according to Schmiedl and Alatoree-Frenk

Discharge(lps)	Head(m)
10-30	40-60
40-60	30-40
60-150	20-30
150-200	10-20

According to Irrigation Department of uttarakhand government Data of different water stream in Distt Uttarakashi

Source(Stream)	Discharge(cusec-gallon)	Dicharge (lps)
Aandri	1.80	51.71
Varuna	4.10	117.79
Kulpuri	9.45	271.49
Kamda	1.50	43.09
Rano	3.30	94.80
Dichli	1.33	38.21
Gamri	2.20	63.20

Power Generation using PAT in various stream at Uttarakashi Uttarakhand

Source (Stream)	Discharge (lps)	Head (m)	Dia of Impeller(mm) $D2=Q^2/H^{1/2}$	Maximum Power Generation(Kw)
Aandri	51.71	35	93.49	17.75
Varuna	117.79	25	162.55	23.11
Kulpuri	271.49	15	264.55	39.94
Kamda	43.09	35	85.34	14.79
Rano	94.80	20	145.55	18.59
Dichli	38.21	40	77.75	14.99
Gamri	63.20	18	127.74	13.29

So we can produce power in pan areas where water stream is easily available. It can give electricity for a small village and 5 to 10 family in rural areas.

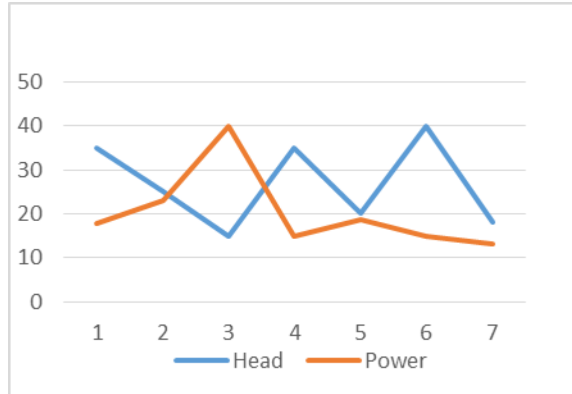

Fig. 1. Head Vs Power

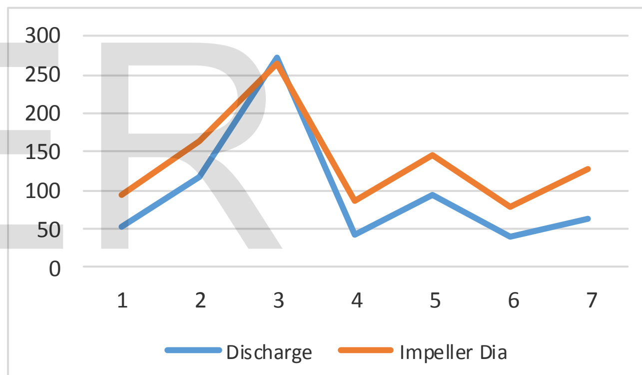

Fig. 2. Discharge Vs Impeller Dia

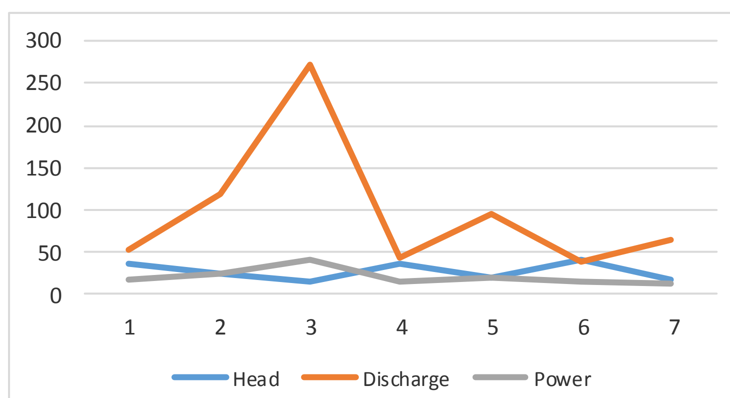

Fig. 3. Head , Power and Disharge

International Journal of Scientific & Engineering Research Volume 8, Issue 12, December-2017
ISSN 2229-5518

Conclusion:

PAT is a good solution for electricity generation in remote and rural areas.They can also be successfullyused in hill areas. The cost for installation for these small hydro project is very low and good for remote areas.

Above study show that in different water stream we can generate power in Kw which is sufficient for a rural and pan areas.

Fig 1 show that in high Head low discharge give Best Efficiency and in the Fig 2 show that impeller dia is depend on the discharge available in the water stream.

So PAT is the best alternative for power generation in remote and pan areas.

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