ABSTRACT

Depletion of fossil fuels, pollution due to fossil fuels, awareness about non conventional source, abundance of water sources in hilly areas changed the attention to renewable source of energy. Hydroelectricity is the term referring to electricity generated by hydro power; the production of electrical power through the use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy, accounting for 16 percent of global electricity generation 3,427 terawatt-hours of electricity production in 2012. Small hydro is the development of hydroelectric power on a scale serving a small community or industrial plant. The definition of a small hydro project varies but a generating capacity of up to 10 megawatts (MW) is generally accepted as the upper limit of what can be termed small hydro.

According to present survey, nearly two billion people in the world have no access to electrical energy. The great majority of these live in isolated rural areas in developing countries, where conventional grid-extension electricity supply is not economically viable, and small diesel sets may be inappropriate due to fuel costs, absence of reliable supplies, and a general lack of technical support. An important characteristic of rural energy demand is its low density: particularly in remote districts, provision must be made for a large number of users with low levels of demand, leading to the need for a wide range of scheme sizes for small power generation for differing household densities.

Induction generator is commonly used generator because of its low cost, low maintenances and long life time. Power electronic control technique like Electronic load control, Decoupled voltage and frequency control(DVFC), variable impedance method, VSI based, STATCOM based control are being used in order to maintain constant output voltage and frequency. Thus we can have a control over active power and reactive power under varying load condition.

Keywords: DVFC, Electronic Load Control, STATCOM, Variable Impedance Method, VSI

I. INTRODUCTION

Small hydro is the development of hydroelectric power on a scale serving a small community or industrial plant. The definition of a small hydro project varies but a generating capacity of up to 10 megawatts (MW) is generally accepted as the upper limit of what can be termed small hydro. Small hydro can be further subdivided into mini hydro, usually defined as less than 1,000 kW, and micro hydro which is less than 100 kW. Micro hydro is usually the application of hydroelectric power sized for smaller communities, single families or small enterprise.
Small hydro plants may be connected to conventional electrical distribution networks as a source of low-cost renewable energy. Alternatively, small hydro projects may be built in isolated areas that would be uneconomic to serve from a network, or in areas where there is no national electrical distribution network. Since small hydro projects usually have minimal reservoirs and civil construction work, they are seen as having a relatively low environmental impact compared to large hydro.

Hydroelectric power is the generation of electric power from the movement of water. A hydroelectric facility requires a dependable flow of water and a reasonable height of fall of water, called the head. In a typical installation, water is fed from a reservoir through a channel or pipe into a turbine. The pressure of the flowing water on the turbine blades causes the shaft to rotate. The rotating shaft is connected to an electrical generator which converts the motion of the shaft into electrical energy.

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II. CONTROL TECHNIQUES

For a low-power rating (less than 50 kW), uncontrolled hydro turbines driving self-excited induction generators (SEIGs) are preferred, which maintain the input hydro power constant needing the generated output power to be held constant at varying consumer loads. This requires a control-label dump load connected in parallel with the consumer load such that the total generated power is held constant. Various types of electronic load controllers (ELCs) for self-excited induction generators (SEIGs). Some of the well-known methods are binary weighted-switched resistors, phase-controlled thyristor-based load controllers, controlled rectifier feeding dump loads, an uncontrolled rectifier with a chopper-controlled dump load, etc.

In the binary weighted three-phase switched resistors, the total resistive load is divided into a different number of elements wherein the system is bulky, prone to failure, and less reliable. In a phase-controlled thyristor-based load controller, the phase angle of back-to-back-connected thyristors is delayed from 0 to 180 as the consumer load is changed from zero to full load. Due to a delay in firing angle, it demands reactive power loading and injects harmonics in the system. It further requires complicated driver circuits. In the controlled bridge rectifier type of ELC, a firing angle is changed from 0 to 180 for single-phase and 0 to 120 for three-phase to cover the full range of consumer load from 0 to 100%. In this scheme, six thyristors and their driving circuits are required and, hence, it is also complicated, injects harmonics, and demands reactive power. The fourth type ELC consists of an uncontrolled rectifier with a chopper [a self-commutating device such as an insulated-gate bipolar transistor (IGBT)] in series with a dump load and it has the following advantages.

1) In this scheme, only one switching device and its driving circuit are required. So the scheme is very simple, cheap, rugged, and reliable.

2) It generates a low value of harmonics and does not demand reactive power. Therefore, it is considered as the most suitable scheme for this application.

3) Only one dump load is required and, hence, it is inexpensive and compact.

The prototypes of ELC are developed and tests are performed on them with SEIG under steady-state and transient conditions to verify the design methodology.
III RESULT

a) Simulation using linear load

The matlab model of induction generator connected to a linear load is shown. A resistive load is connected and the THD is measured for the output signal. It is seen that the THD is less than 20% and power factor is 0.93. The capacitor will generate the required reactive power. The parameters are being determined for various load conditions. The matlab model for two different load conditions is shown.
The simulation result of induction generator connected to a linear load is shown. The output is a three phase sine wave.

The matlab model for a different load value is shown.
Fig 3.4: Harmonic spectrum

<table>
<thead>
<tr>
<th>LOAD</th>
<th>VOLTAGE MAGNITUDE(V)</th>
<th>THD (%)</th>
<th>POWER FACTOR</th>
<th>SPEED(RPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>725.8</td>
<td>41.9</td>
<td>.36</td>
<td>1979</td>
</tr>
<tr>
<td>172.25</td>
<td>611</td>
<td>29.89</td>
<td>.939</td>
<td>1734</td>
</tr>
<tr>
<td>100</td>
<td>439</td>
<td>8.75</td>
<td>.73</td>
<td>1490</td>
</tr>
<tr>
<td>50</td>
<td>265</td>
<td>4.36</td>
<td>.12</td>
<td>1308</td>
</tr>
</tbody>
</table>

The finding shows that the output voltage and power factor vary continuously with the variation in load value. The value of the THD is also found to vary due to variation in the load value. The result shows that the need of STATCOM in order to regulate the terminal voltage and frequency.

b) Simulation using non linear load

Fig 3.2: MATLAB model for non linear load.
The non linear load is an uncontrolled diode bridge rectifier. The simulation result shows that a high value of THD and power factor is reduced. The output voltage is highly affected by load condition.

![Fig 3.5: simulation result](image)

<table>
<thead>
<tr>
<th>LOAD (V)</th>
<th>VOLTAGE MAGNITUDE (V)</th>
<th>THD (%)</th>
<th>POWER FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>257</td>
<td>42.14</td>
<td>.12</td>
</tr>
<tr>
<td>172.25</td>
<td>150.67</td>
<td>50.1</td>
<td>.68</td>
</tr>
<tr>
<td>250</td>
<td>108.32</td>
<td>50.68</td>
<td>.70</td>
</tr>
<tr>
<td>300</td>
<td>100.72</td>
<td>50.85</td>
<td>.71</td>
</tr>
</tbody>
</table>

The result shows that with the variation of load, the voltage gets highly distorted. This shows the requirement of STATCOM based control strategy in order to maintain constant voltage with variation on the load value.

c) Design of Electronic load Controller

ELC consists of an uncontrolled rectifier and chopper with a series “dump” load. The advantages of the circuit is:

1. In this scheme, only one switching device and its driving circuit are required. So the scheme is very simple, cheap, rugged, and reliable.
2. It generates a low value of harmonics and does not demand reactive power. Therefore, it is considered as the most suitable scheme for this application.
3. Only one dump load is required and, hence, it is inexpensive and compact.

The ELC is the combination of an uncontrolled rectifier, a filtering capacitor, chopper, and a series dump load (resistor). The uncontrolled rectifier converts the SEIG ac terminal voltage to dc. The uncontrolled rectifier output has the ripples, which should be filtered and, therefore, a filtering capacitor (C) is used to smoothen the dc voltage. An IGBT is used as a chopper switch. A suitable gate driver circuit has been developed that turns on the chopper switch when the consumer load on SEIG is less than the rated load and turns off the chopper switch when consumer load on the SEIG is at a rated value. When the chopper switch is switched on, the current flows through the dump load and consumes the difference power (generated power-consumed power) which results in a constant load on the SEIG and, hence, constant voltage and frequency at the load.
The MATLAB model of ELC for self excited induction generator is shown.

The SEIG system with the STATCOM-based voltage regulator feeding nonlinear balanced/unbalanced load is simulated.
IV. CONCLUSIONS

The study helped to understand the behaviour of linear load and non linear load. A suitable control strategy was developed in order to control the output values. The variation of load voltage with the variation in load value was observed. Electronic load control (ELC) was simulated. ELC has advantage like less harmonic, inexpensive, simple make it easy to analysis and design ELC. It could also be seen that the control strategy can be used for load balancing, neutral current compensation and harmonic elimination.

REFERENCES

9. V.Rajagopal „Bhim Singh „Improved Electronic load controller for off grid induction generator in small hydro power generation” IEEE Electronic conference on power electronics,,2011