Characteristics of the static and dynamic operating modes of the asynchronous generator in renewable energy sources and the production of electric energy control through a frequency converter

Nurali Pirmatov¹, Sodiqjon Mahamadjonov², Muhammadsodiq Matqosimov²*, and Humoyun Haydarov²

¹Tashkent State Technical University, Tashkent, Uzbekistan
²Andijan Machine-building Institute, Andijan, Uzbekistan

Abstract. This article considers the use of an asynchronous generator excitable through capacitor elements in mini and micro hydropower plants in the case of rational use of renewable energy sources, and the different operating modes and different work savings of this asynchronous generator, and the current and voltage changes and their characteristics.

1 Introduction

Currently, the construction and rational use of mini and micro-hydroelectric power plants is considered one of the pressing issues, taking into account the growing demand for renewable energy sources. With this in mind, the use of an asynchronous generator instead of a synchronous generator in mini and micro GES is bringing us a number of amenities. According to the reversion property of electric machines discovered by the Lens, it can work in motor mode as well as in generator mode.[4]

2 Materials and methods

In terms of constructive execution, the asynchronous generator is no different from the asynchronous motor. To switch from Motor mode to generator mode, the stator coil is connected to the grid using a primary motor to rotate the rotor of the asynchronous machine to the rotating side of the stator field, making the rotation frequency greater than the field rotation frequency \((n > n_1)\). In this case, the slip of the machine will have a negative signal \([1,4]\).

\[ (-s) = (n_1 - n) / n_1 \]  

* Corresponding author: muhammadsodiqmatqosimov@gmail.com
To operate an asynchronous motor in generator mode, mechanical energy is supplied to the motor shaft at a speed 5÷10% higher than the nominal speed of rotation of the motor. In practice, the asynchronous generator has a normal operating mode (-s) ≤ (6 - 8)%. In asynchronous machine generator mode, the conductors of the stator and rotor windings intersect in the opposite direction, as if with a circular field. In Motor mode, these conductors intersect in a suitable direction.[5].

In order for us to operate an asynchronous motor in generator mode, a capacitor connection to the stator Circuit of the motor is required, since the asynchronous motor must consume reactive power to generate a magnetic field in the stator windings in this case, we definitely need a capacitor. Depending on the power of the asynchronous motor, the selected capacitor is connected in accordance with the stator windings of the motor, and when the asynchronous motor Valve is given mechanical energy at a speed greater than the nominal speed, the slip becomes negative and the asynchronous motor begins to operate in the generator mode and produces electrical energy. Choosing a capacitor to match the power of the motor is considered important in the jud, with an incorrectly selected capacitor showing a negative effect (reduction or increase in voltage and frequency from the nominal value) on the parameters of the electricity the generator is producing.[5-6].

Currently, the use of an asynchronous generator in mini and micro GES is considered very useful because no additional fixed current source is required to excite an asynchronous generator—this leads to a significant reduction in the cost of electricity being produced.[5].

![Principle scheme of control of microhydroelectric plants asynchronous generator.](image)

Through this control scheme, the management of the elimination of asymmetric States occurring in transient processes in the qualitative supply of electricity produced by the asynchronous generator to consumers in microhydroelectronic stations is shown. In the production and transmission of quality electrical energy (1) with the help of a Taxo generator i.e. hydroturbine (2) with the aim of starting an asynchronous generator, a mechanical rotating moment is given asynchronous generator with the help of (3) capacitor elements, which provide the asynchronous generator with a reactive power enregia that receives from the network at a speed 5-10%. For the purpose of qualitatively delivering the generated current or voltage to the network or consumer (4) [VD] two semiconductor diode elements are used in each phase, which is installed on the input and output sides, this is because our asynchronous generator produces alternating current or voltage which in turn flows back or forth within a unit of time we know that we then see in the garfik that determines the highest point in the sinusoidal and in which the gaps are left (5)[VT] filtering capacitors are used to fill these gaps, after the filtered straightened voltage is generated (8) the control device takes control of each state with no more than ±2% and commands (6) transistor switches they transmit to the network by Yani (shin) shirota pulse modulation as a three-phase alternating current or voltage (7) the voltage frequency extends.
a constant signal to the (8) control structure through the vat current sensors. After the Nominal voltage is generated, the control structure (9) sends a signal until the automatic reconnect while the automatic reconnect connects the quality electricity generated to the network or consumer.

3 Results and Discussion

Technical parameters of the asynchronous motor are presented in Table 1

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Power, kW</th>
<th>At Nominal load</th>
<th>$\cos \varphi$</th>
<th>$M_n$</th>
<th>$M_{min}$</th>
<th>$M_{max}$</th>
<th>$I_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A80A6У3</td>
<td>0.75</td>
<td>8.6 69</td>
<td>0.74</td>
<td>2.0</td>
<td>1.6</td>
<td>2.2</td>
<td>4</td>
</tr>
</tbody>
</table>

During the experiment, the characteristics of the asynchronous generator from the engine mode to the generator mode, operation without loading, current and voltage parameters in the loading and overload operating modes were obtained. In the first part, the asynchronous generator's start-up characteristic gave the following appearance.

![Fig. 2. Startup characteristic of an autonomous asynchronous generator.](image)

This figure shows a time dependence graph of [U] voltage [t] in this graph we can see that starting an asynchronous engine is that it takes 2-3 seconds to switch from engine mode to generator mode.

At the next stage, the characteristic of operation of the asynchronous generator without loading was considered. In this, the characteristic has the following appearance:

![Fig. 3. Performance characteristic of autonomous asynchronous generator without load.](image)
In the load-free mode of operation, it is known to us that we see that the phase voltage \( I=0 \) is equal to \( U_n=220 \) without change in each phase.

The current and voltage characteristics of the asynchronous generator in switching from bootless mode to boot mode are shown in Figure 4.

![Figure 4](image1.png)

**Fig. 4.** A is by current strength; b is by Voltage.

From Figure 4-A it is known that in the mode of operation without loading of the asynchronous generator, the current force \( [I] \) is known to be zero, when the load on the generator is connected, at a time interval of 2 seconds, we can see that the current force changes by 35\% and returns to the nominal state after a transient process. Figure 4-B revealed that the voltage \([U]\) value in switching from the generator’s load-free operating mode to the load operating mode varies by 42\%. It takes 3 seconds to reach a stable state.

![Figure 5](image2.png)

**Fig. 5.** Characteristics of switching an autonomous asynchronous generator from nominal mode to supercharging mode-the values of voltages in 3 phases of the stator are 17 seconds.
Fig. 6. Characteristics of switching an autonomous asynchronous generator from nominal mode to supercharging mode-current values in 3 phases of the stator are 20 seconds.

Fig. 7. Characteristics of the transition of an autonomous asynchronous generator from a nominal mode to a symmetric load mode-values of voltages in 3 phases of the stator.

Fig. 8. Characteristics of switching an autonomous asynchronous generator from nominal mode to symmetric load mode-current values in 3 phases of the stator.
4 Conclusion

Conclusions made based on the use of asynchronous generators used in microgames and the analysis of various operating modes and the results of the experiment carried out:

- An asynchronous generator that excites itself through its capacitor elements will have some efficiency compared to synchronous generators.
- The ease of maintaining the frequency of the electrical energy produced by the asynchronous generator in one norm further increases the demand for the asynchronous generator;
- Occurs in the operating modes of the generator, which is one of the necessary factors to detect changes in current and voltage patterns in transient processes and eliminate this.

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