

# On PM Tubular Linear Synchronous Motor Modelling

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*Abstract:* In this paper a new approach is made on PM tubular linear synchronous motor (PM-TLSM) modelling, considering a non linear model. This model allows the incorporation of PM elements characteristics. The straight forward approach induces robust simulation results for tubular linear machines, without resorting to complex variable transformations.

*Key-Words:* Linear machines, Tubular motor, Permanent-magnets, Modelling and Simulation.

## 1 Introduction

A linear motor applies force directly to a load, and does not require any intermediate mechanism to convert rotary motion into linear motion. Linear motors are capable of high speeds, fast acceleration, and accurate positioning.

The linear motors are employed in a wide range of electromechanical systems, such as robotics and factory automation, processing and packaging equipment, machine tools, transfer equipment, aerospace industry and transportation systems. An industrial applications issue of the linear actuators is present in [1].

When providing motion for people-moving devices or virtual reality capsules, it's important to provide a clean environment. The linear motors can offer significant advantages over conventional linear motion systems, such as hydraulic linear actuators, motors drives by cams, ball screws and belts, in terms of efficiency, low cost maintenance, no power loss in rotary-linear conversion, speed and force control and positional accuracy [2].

The linear synchronous machines (LSM) are selected for some applications, because they have significantly higher force production than linear induction and switched reluctance motors. This preference is justified by the improvements of permanent magnet materials and power electronics devices [3].

There are several topologies of LSM, these topologies vary with some parameters i.e. excitation mode, type and permanent magnets placement, slotted or slotless armature design.

A permanent magnet tubular linear synchronous motor (PM-TLSM) topology is considered in this paper. The different PM-TLSM topologies and their comparative studies are present in [4]-[6].

## 2 PM Tubular Linear Synchronous Motor

### 2.1 Development of linear motor geometries

To understand the linear machines modelling based on rotary machines knowledge, geometrically it can be "cut" along radial plane and "unrolled". This is exemplified in Figure 1(a) and Figure 1(b). Applying this process to a PM rotary synchronous motor a PM flat LSM is obtained. The PM-TLSM can be developed from flat linear motors by "rolling" them around their longitudinal axis. The permanent magnets, initially oriented along the length of the linear shaft, now form a stack of alternating magnetic polarity rings, Figure 1(c).

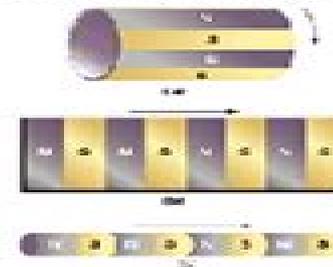


Fig.1: (a) Rotary motor; (b) Flat linear motor; (c) Tubular linear motor.

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