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Rotational electromagnetic-field-aided false twisting of metallic filaments

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In the present research, a novel method based on previous work is improved to exert false twist of metallic filaments on the basis of a rotational electromagnetic field. Primarily, the effect of the rotational force of a single-phase induction stator on current-carrying conductive filaments is studied. Thereafter, the prototype of the proposed system is designed and tested. The analytical and experimental results prove the capability of the method in false twisting of conductive (metallic) filaments. The proposed method can be employed as a false-twisting box for polymeric conductive and magnetic filaments.

Keywords: metallic filament; false twisting; rotational electromagnetic field; single-phase induction motor

Introduction

In recent years, applications of conductive fibres in textile products have been widely developed, especially in E-textile, smart clothing and textronic (Gniotek & Kruciska, 2004). The prerequisite for utilising conductive filaments as yarns in textiles is to interlace them in order to be comfortable to touch.

Recently, magnetic field was used for electrospinning of fibres (We, Yu, He, & Wan, 2007). In a previous study (Payvandy, Latifi, & Agha-Mirsalim, 2008; Payvandy, Latifi, & Moghani, 2007a, 2007b) the theoretical and experimental analyses demonstrated the feasibility of the 'twisterless' method, which interlaced current-carrying metallic filaments applying the rotational magnetic field provided by permanent magnets. The proposed method faced the limitation of magnets' rotational speed because of their mechanical driver. To overcome this limitation, the effect of electromagnetic field on metallic filaments with electrical current is studied. The principle of a single-phase run-capacitor induction motor is used for this purpose.

Methodology

Small-power (generally below 2 kW) induction machines have to operate mostly with single-phase AC power supplies that are readily available. For constant speed applications (the most frequent situation), the induction motor is fed directly from the available single-phase AC power grids. In this case, it is called single-phase induction motor (Boldea & Naser, 2002). To be self-starting, the induction machine needs a travelling field at zero speed. This, in turn, implies the presence of two windings in the stator, while the rotor has a standard squirrel cage. The first winding is called the main winding, while the second winding is called auxiliary winding as shown in Figure 1.

As observed, the rotational rotor is the cause of phase differences in stator poles, which make the rotational magnetic field. It seems that by replacing the rotor with metallic filaments, they can be twisted with each other as illustrated in Figure 2. Since the space among stator poles is too big to induce current in the filaments, DC is used in filaments. As is shown in Figure 2, the metallic filaments, which carry opposite currents, are fed to the centre of the rotational electromagnetic field provided by a single-phase run-capacitor induction stator. The forces induced in the filaments are

(1) electromagnetic force between two current-carrying filaments,
(2) electromagnetic force between current-carrying filaments and the rotational electromagnetic field and
(3) electromagnetic force exerted by the interaction of induced current from the back electromotive force to a filament by a rotating electromagnetic field.

The effect of electromagnetic force between current-carrying metallic filaments was described and analysed in a previous work (Payvandy et al., 2008).

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