[Difference of the Back EMF calculation between two methods]

Hello Dear!

My name is John Kang in South Korea and doing a job to design a BLDC motor.

To verify the some result like Back EMF of slotless BLDC motor, I perform the Back EMF calculation using two methods.

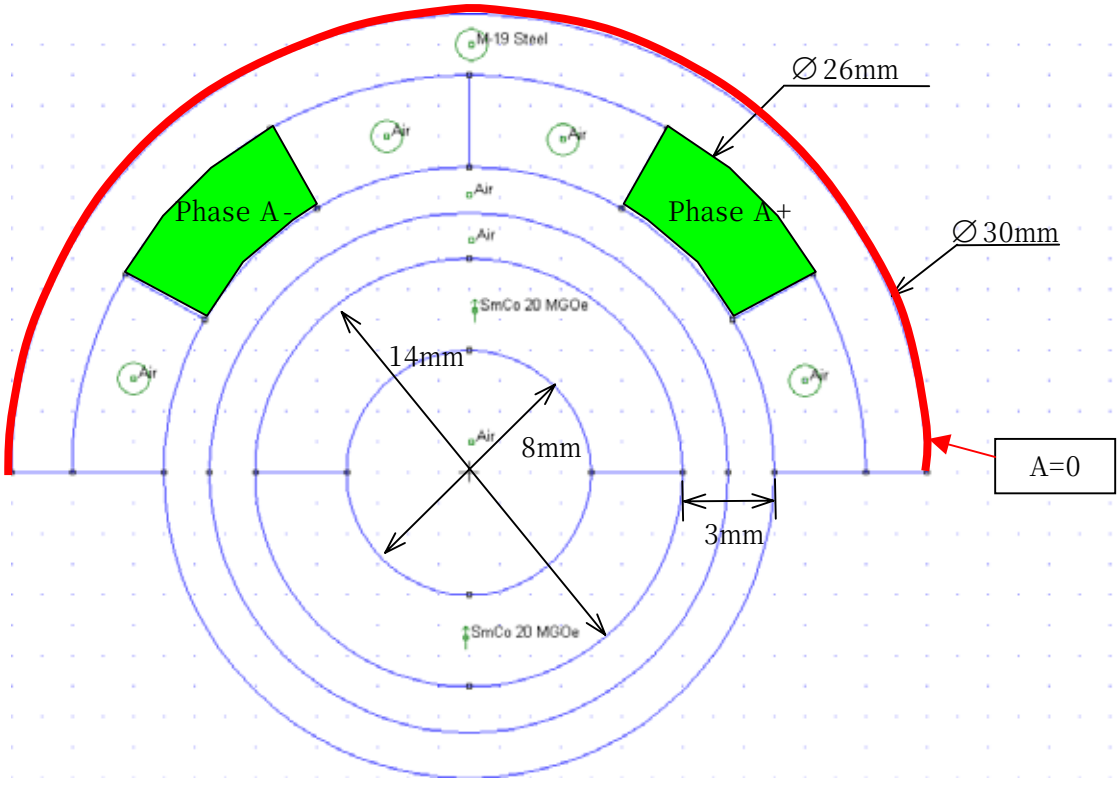
Fisrt one is classic Faraday's law. This formula is $e = B \cdot l \cdot v \cdot N$. (B : Magnetic Flux Density [T], l : stack length [m], v : line velocity of rotor [m/s], N : total conductor number)

Second one is using magnetic vector potential and lua script. Basic formula is like followings.

$$e = -N \times \frac{d\Phi}{dt} = -N \times \frac{d\Phi}{d\theta} \cdot \frac{d\theta}{dt}$$

(N : total conductor number, Φ : magnetic flux [Wb])

My model description is this.



- Total serial coil turns : 48 (12 turn/coil)

[1] First Method

- Magnetic Flux Density (Peak value) : 0.3 [T]
- Stack Length : 1 [m]
- Rotation Speed : 1,000 [RPM]

Back EMF $e = 0.3 \times 1 \times 0.89 \times 48 = 12.8[V]$ per 1 phase

[2] Second Method

I used the followong 2 Lua script files and moved rotor.

[move.lua]

```
pi = 3.141592

for theta=0,180,1 do

        open_femm_file("design.fem")

        seteditmode("group")
        selectgroup(11)
        move_rotate(0,0,theta)

        save_femm_file("temp.fem")
        analyse()

        handle = openfile("angle.txt","w")          // For saving angle data [deg.]
        write(handle,theta,"₩n")
        closefile(handle)

        runpost("move_post.lua")                    // Post processing lua

end
```

[move_post.lua]

```
pi = 3.141592

len_stack = 1                           // unit length
deg = 1                                 // moving degree of rotor [deg.]
coil_turn = 48                          // total conductor number

handle = openfile("rpm.dat","r")        // to open motor speed file : 1,000 rpm
rpm = read(handle,"*n")
closefile(handle)

handle = openfile("weber.txt","r")      // to open magnetic flux data saved in previous step
phi0 = read(handle,"*n")
closefile(handle)

handle = openfile("angle.txt","r")      // to open moving angle of rotor
ini_ang = read(handle,"*n")
closefile(handle)

handle = openfile("bemf.dat","a")

groupselectblock(1)
A1 = blockintegral(1)                   // to calculate of average vector potention in coil area
clearblock()

groupselectblock(2)
A2 = blockintegral(1)
area = blockintegral(5)
clearblock()
phi = (A2 - A1) * len_stack / area
```

```
-- 1 Deg. = 0.01745 Radian
unit_bemf = (-1) * (phi - phi0) / 0.01745 * rpm * pi/30 * coil_turn

write(handle,ini_ang," ",phi,"     ",unit_bemf,"₩n")
closefile(handle)

handle = openfile("weber.txt","w")
write(handle,phi,"₩n")
closefile(handle)

exitpost()
```

Unfortunately, from this method, I got 16.5[V] of Back EMF peak. What is the reason? I didn't find any mistake in lua. I think this concept to calculate the Back EMF is right. I wanna to hear about your advise.