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**The X-Factor** EARL BABCOCK, Institut Laue Langevin, THAD WALKER, University of Wisconsin-Madison, WANGCHUN CHEN, THOMAS GENTILE, NIST — Applications of polarized $^3$He gas, in particular neutron spin filters and targets for electron scattering, require the highest possible $^3$He polarization $P_{He}$. We recently reported that the $^3$He polarization achievable using the spin-exchange optical pumping method is often limited to 75%, although the cells were polarized for conditions in which the traditional rate balance model would predict close to 100% $^3$He polarization. In a more extensive study of cells with a larger range of surface to volume ratio (S/V), we have found that the achievable polarization saturates at a value of 20% to 50% below that of the measured alkali-metal polarization. In all respects this limit to the $^3$He relaxation behaves as if there exists an additional temperature-dependent source of $^3$He relaxation. This results in the measured $P_{He}$ to be precisely what we would expect from a standard rate balance argument if the extra relaxation is included, however the source of the extra relaxation is unknown. We have found that the $^3$He relaxation varies from 20% - 100% of the spin exchange rate depending on the cell tested. Here we present evidence from studies to show that the extra relaxation is dependent on S/V, but that this is not the only relevant parameter. Preliminary studies indicate that the $N_2$ and $^3$He pressure may be relevant, but further work is necessary.

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