Acoustic Emission Localization using Laser Structural Training with Neural Network on Hydraulic-tested Type 4 COPV

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Composite overwrapped pressure vessels (COPVs) are commonly used for high-pressure gas storage and as propellant storage for space launch vehicles. Among different types of COPVs, type 4 is increasingly popular due to its high strength-to-weight ratio and good corrosion resistance. However, type 4 COPV has a unique structure, with a plastic liner inside and composite fiber wrapped around it. Therefore, it is crucial to monitor the structural health of composite fibers in the COPVs using structural health monitoring methods. In this paper, we propose using the acoustic emission localization method to monitor the state of COPVs. We use a guided wave laser ultrasonic propagation imaging method (GUPI) to acquire laser elastic waves on the surface of COPVs. At the same surface, we acquire the pencil lead breakage (PLB) signal to reproduce an acoustic emission signal. We modulate the frequency domain of both signals with a neural network, calculating the magnitude ratio of the Fast Fourier Transform (FFT) results of both signals. We train the neural network to match the frequency domain components of the two signal types. We use frequency domain modulation to localize the acoustic emission source with the GUPI scan result. We carry out a hydraulic test to reproduce cumulative damages on the COPV. With both pristine and hydraulic-tested COPV, the acoustic emission localization algorithm with GUPI and neural network works well for both cases.